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IRON AND STEEL ENGINEER

VOL. XIII APRIL • 1936 NO. IV

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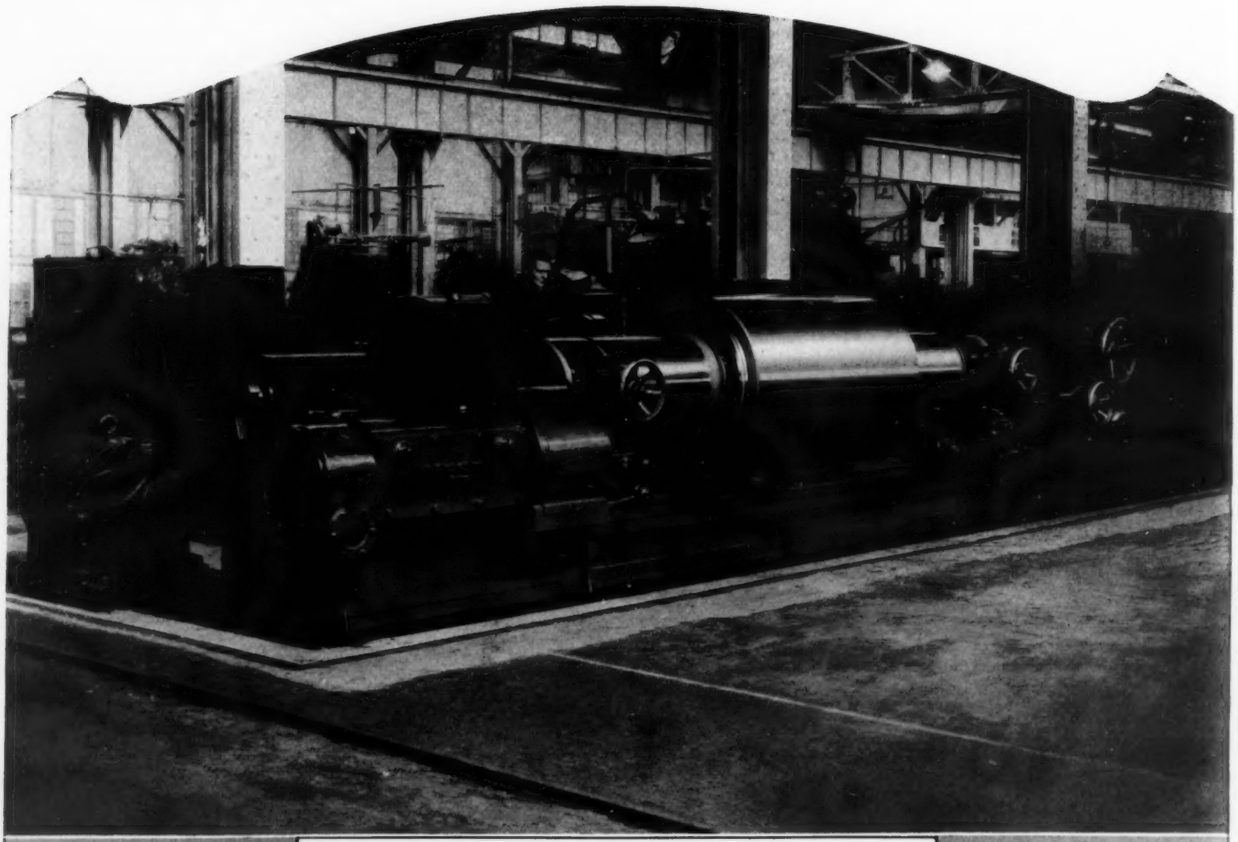

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The Association's Activities

DURING the 28 years of the Association's activities more than 4000 papers and talks have been presented to the members and other representatives of the steel industry. The subjects discussed included first those of an electrical nature. It was the development of electrical engineering as applied to the steel mills which was uppermost in the minds of the steel mill engineers when the Association was formed, as it presented the greatest possibilities for the improvement of rolling mill practice.

The items cover in general the generation, transmission, conversion and application of electric power; design and application of large rolling mill motors and small motors for the auxilliary machines; the necessary control equipments, brakes and protective devices; electric furnaces; electric welding and lighting.

It is undoubtedly true that the early pioneers in the Association's activities were men of broad vision, for through the cooperative efforts of the Association's members, Associate and Active, much has been accomplished in the bringing of steel mill electrification to the high degree of perfection and completeness of today.

As the Association grew and aroused the interest of other engineers of various departments of the steel industry, subjects of a nature other than electrical were presented. Papers on the subject of blast furnaces and open hearth began to appear and today the programs include contributions from the Combustion, Mechanical, Lubrication and Safety Engineers. In fact all phases of the making, processing and finishing of iron and steel are discussed and more and more the Association's activities are becoming thoroughly representative of the iron and steel industry.

Perhaps no better example of this advancement in steel mill practice than the wide continuous strip mill can be cited. The problems of individual drive with the exactness of speed control and speed relation, and the problems of suitable roll neck bearings for the unusually heavy pressures, are subjects which have been sponsored by the Association over a long period. The result has been many valuable papers and discussions, all of which have had their part in the development of this notable improvement.

One of the outstanding efforts of the Association regarding originality and cooperation has been the work it has done regarding the safety movement. The Association was the first to foster the safety movement in such a way that it attracted the attention of other industries and thus lead to the formation of a general national body. This is an achievement of which the Association can well be proud.

Other cooperative accomplishments of much value is included in standardization work covering the subject of motors, cranes and other electrical items.

The presentation of papers is made principally at the monthly meetings of the several sections including Philadelphia, Pittsburgh, Cleveland, Chicago and Birmingham and also at the annual convention.

One of the most valuable educational features of the Association is embodied in the annual exhibit of machinery and devices used largely by the steel industry. It is here that one may see the latest developments and acquaint themselves with what is available for practically every mill requirement.

Supplementing the annual meeting, arrangements are made for a spring conference which is held at a central point, making it very convenient for steel representatives to attend. This meeting arouses a great deal of interest and is always very well attended. The conference this year will be held in Youngstown, Ohio, April 22 and 23, headquarters at the Ohio Hotel. The program includes a varied list of interesting papers and an inspection trip to the 43″ continuous hot strip mill of the Carnegie-Illinois Steel Corporation, McDonald Works.

The activities as mentioned above indicate the purpose and scope of the Association and it is felt that with a better appreciation of these points by members of the iron and steel industry and others interested that even greater cooperation will be secured in the future.

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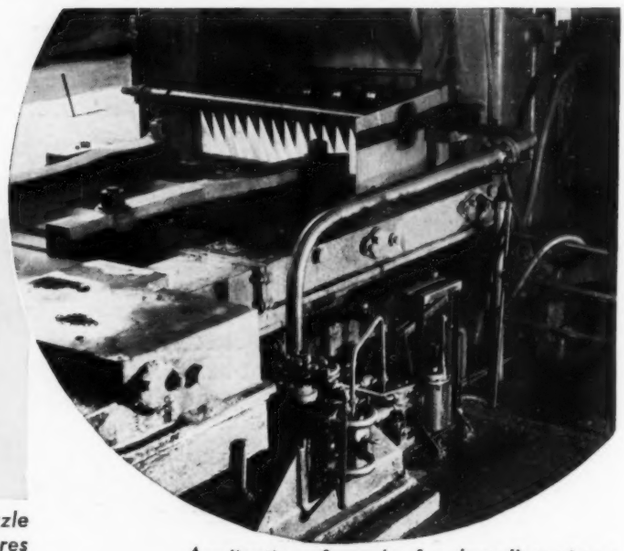
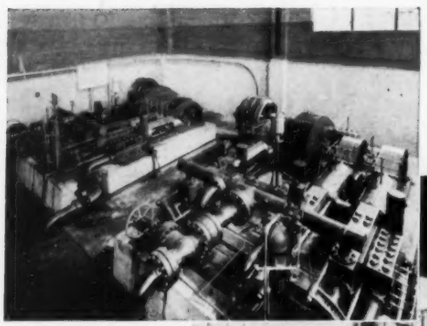
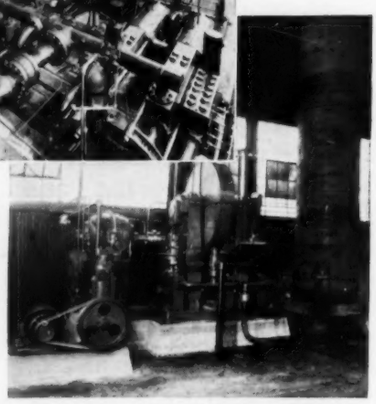


Application of nozzles for descaling at one stand of a wide continuous strip mill





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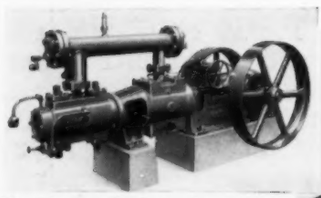

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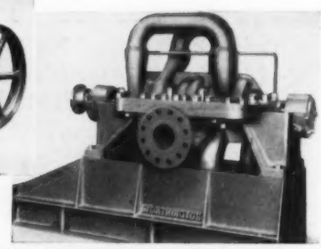

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A. I. & S. E. E.

ANNUAL SPRING CONFERENCE

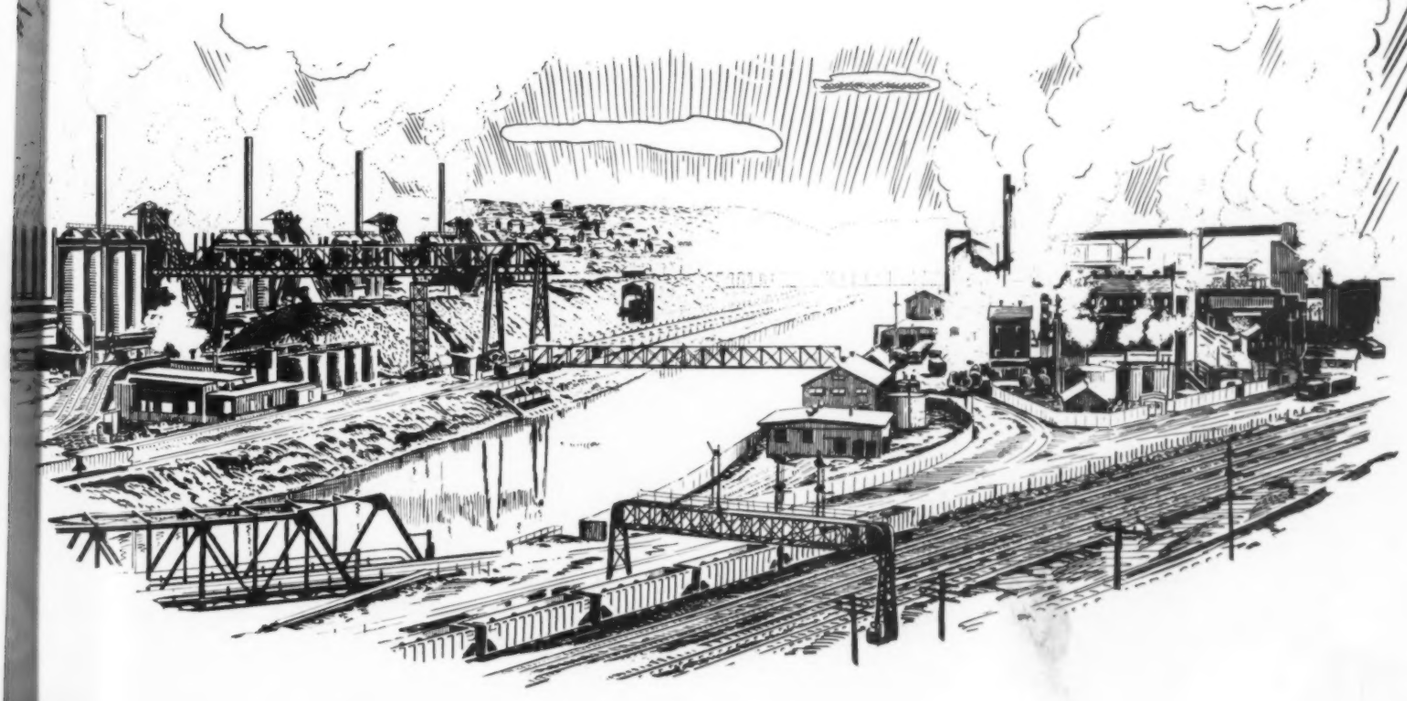
AUSPICES OF COMBUSTION ENGINEERING DIVISION

OHIO HOTEL . . . . . YOUNGSTOWN, OHIO

Containing

Abstracts of Papers which will be delivered .... Committees .... Complete description of Carnegie-Illinois Steel Corporation's Hot Strip Mill, McDonald, Ohio and all other details incident to the meeting.

APRIL 22 - 23, 1936



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Republic Steel Corporation,
Massillon, Ohio.

A. I. & S. E. E.

Spring Conference

AUSPICES COMBUSTION ENGINEERING DIVISION

Wednesday Evening, April 22 **Thursday all day, April 23**

Ball Room, Ohio Hotel, Youngstown, O.

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Carnegie-Illinois Steel Corporation,
Youngstown, Ohio.

GENERAL SECRETARY
C. J. DUBY, *Chief Engineer,*
Republic Steel Corporation,
Warren District,
Warren, Ohio.

PROGRAM

7:30 P. M. Wednesday

"*Descaling Hot Steel Hydraulically*", by J. E. HOLVECK, Sales Engineer, Worthington Pump and Machinery Corp., Pittsburgh, Pa.

"*Control and Recording of Rolling Mill Pressures*", by M. STONE, Engineer United Engineering and Foundry Company, Pittsburgh, Pa.

"*The Measurement of the Temperatures of Hot Moving Objects*", by A. E. KROGH, Sales Engineer, Brown Instrument Company, Philadelphia, Penna.

9:30 A. M. Thursday

"*Circular Furnace for Ingot Heating*", by M. H. MAWHINNEY, Consultant, Salem Engineering Co., Salem, Ohio.

"*Modern Refractories in the Steel Industry*", by L. J. TROSTEL, Chief Chemist, General Refractories Company, Baltimore, Md.

"*Tension Control in Cold Strip Rolling*", by F. MOHLER, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

"*A Description of 43" Hot Strip Mill*", by L. N. MCDONALD, General Superintendent, Carnegie-Illinois Steel Corp., Youngstown, Ohio.

1:00 P. M. Thursday

SPECIAL FEATURE

Thursday Afternoon, April 23, Inspection trip to 43" Hot Strip Mill, Carnegie-Illinois Steel Corporation, McDonald, Ohio. Special train will leave the Ohio Hotel at 1:00 P. M. Price $2.00 per person.

At the special request of the Carnegie-Illinois Steel Corporation officials, the members and guests are asked to use the transportation facilities which the Association will provide.

Reservations must be made for this trip.

Committee on Arrangements

On this and subsequent pages are presented a few of the many prominent steel mill officials who will participate in various functions of the Spring Engineering Conference.

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Jones & Laughlin Steel Corporation
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Sharon, Pa.

Circular Furnace for Ingot Heating

M. H. MAWHINNEY, Consultant,
Salem Engineering Company
SALEM, OHIO

Abstract of Paper to be presented before the A. I. & S. E. E. Spring Engineering Conference

▲ THIS paper will describe the design and operation of the new circular ingot heating furnaces in operation at several plants.

Tracing the development of soaking pits, we find very little important development in the long interval from the introduction of the Siemens principle, except the one-way pits with recuperators which have been popular in recent years. The development of the circular pit to be described in this paper also departs from the Siemen's regenerative principle, and introduces a number of new concepts to the science of ingot heating or "soaking".

The circular furnaces built to date are of two sizes. One is 11′ 0″ in diameter at the charging hole, and the other is 16′ 0″ in diameter with twice the charging capacity of the smaller pit. As an example of the number of ingots which may be put under cover in these pits, one of the smaller size is now being charged with nine ingots 21″ x 23″ and a larger pit is regularly holding twenty-five ingots 19″ x 21″.

The circular furnace is fired from the bottom around a firing ring which is larger in diameter than the charging hold of the furnace. The lining is of non-spall brick, backed up with insulating brick on bottom, sides and cover. The burners fire tangentially around the outside and the products are vented at the center of the furnace bottom. Those furnaces built to date have been without recuperators, and without any stacks, except low chimneys to exhaust the gases at a level above a man's head.

On all pits automatic temperature control is provided consisting of platinum thermocouple and standard pyrometer equipment. On all gas fired furnaces, ratio control is used to automatically maintain a given fuel-air ratio at all rates of firing. Burners have been of the premix type with resulting clear flame in the furnace.

The cover on these furnaces is a refractory dome arch, carried by a self-contained crane, travelling on bloom rail tracks. Both traversing and lifting mechanisms are used to permit lowering the cover into a sand seal, and electrical interlocks are provided to avoid any accidents from improper operation of the controls.

In the design of this furnace, every effort has been made to incorporate those features which have proved their value in metallurgical heating equipment other than those commonly found in steel mills. These features include sand sealing of openings, elimination of stacks, atmosphere and temperature control, all of which are standard practice in high temperature heat treating and forging furnaces common to those industries turning out a finished product to very close metallurgical specifications. The adaptation of the circular form also results from the uniform heating found to be possible in heat treating furnaces of this shape, where heat circulation is vigorous and where each piece is exposed to the same heating conditions.

The principal advantages found from operation of these furnaces are as follows:

1—Elimination of cold corners.

2—Symmetrical application of heat to all ingots.

3—Maximum temperature uniformity resulting from bottom firing, vigorous circulation, and a multiplicity of small burners.

4—Minimum depth of pit due to bottom firing.

5—Two-way cover operation reduces radiation from working opening.

6—Control of atmosphere made possible by sealed cover and absence of stack draft.

7—Automatic control of fuel-air ratio reduces scale and causes making of bottom to be easier and less frequent.

8—Automatic control of temperature with simple standard instruments protects ingots and lining from overheating.

9—Results with fuel oil have been equally as good as those with various gas fuels which have been applied.

10—Rapid heating of cold ingots continuously without any "killing" of the pit.

In conclusion, it may be said that the application of principles learned from the design of heat treating equipment, has resulted in a soaking pit with several apparent advantages in operation.

M. H. MAWHINNEY

Modern Refractories in the Steel Industry

By L. J. TROSTEL, Chief Chemist,
General Refractories Co.,
BALTIMORE, MD.

Abstract of Paper to be presented before the A. I. & S. E. E. Spring Engineering Conference

▲ THE manner in which the refractories industry has organized itself to meet the needs of the steel industry for improved refractories of all types suitable for furnaces of changing design and melting and heating operations of increased severity is discussed.

The improved refractories used by the steel industry today have not necessitated resort to new raw materials. This situation has been accomplished by drawing upon the accumulation of data on fundamental properties of the well known refractory oxides and reducing these data to a practical basis. Changes in many of the older unit operations in manufacturing have resulted, such as, controlled grain sizing, more thorough incorporation of the plastic bonding materials, de-airing of both stiff mud and dry press batches, increasing the volume stability of the brick, and the application of extremely high molding pressures as in the production of unburned basic brick. Increase in bulk density of the finished product has been the objective of most of the processing changes.

Unburned chrome and magnesite brick in the basic class, super-duty brick in the fireclay class, highly crystalline aluminum silicate refractories of the sillimanite type, as well as insulating firebrick typify the results of the revised practices of the refractories manufacturers.

The applications to furnace construction of both improved and special refractories are pointed out from the viewpoint of present requirements and in the light of new or special requirements.

Checkers for stoves have been improved by de-airing and frequent changes in design. The use of super-duty fireclay brick offers further opportunities for improvement.

Blast furnace brick made from the Kentucky clays are considered the best from the standpoint of density and workmanship.

For open-hearth bottoms a high-lime magnesite is one of the new materials available. Furnace banks and tap-hole refractories require better basic materials to meet more rigid requirements of special steels and because of the high temperatures required for these steels.

L. J. TROSTEL

In front wall piers, back walls, corner walls, ports, downtakes and bulk heads, unburned chrome brick are advantageously replacing silica.

Reference is made to the potentialities of the basic roof.

Insulation on the exterior of the open-hearth furnace above the charging floor raises the mean temperature of the refractories in use. This increases the severity of the fluxing action of the basic oxides and shrinkage. A more extended use of the improved basic brick now available is indicated.

For special grades of steel, magnesite nozzles may be advantageously used to replace clay nozzles. Increased pouring temperatures are thus possible, erosion of the nozzle is decreased and more uniform pouring results.

An analysis of the problem of the proper fireclay brick to use in various mill furnaces is handled from the standpoint of such properties of the brick as refractoriness, volume stability, and spalling as related to the temperature and frequency of shut-downs of a particular furnace.

The point is made that the refractories manufacturer has progressed rather far in his knowledge of how to induce and control the properties of his materials. An objective to be pursued in the future is to cooperate with the trained refractories engineers, gradually filtering into the steel industry. Thereby, a proper breakdown can be made of the complex factors entering into the destruction of refractories and permit the refractories manufacturers to apply their ability to produce brick of specific function.

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General Manager
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Youngstown, Ohio

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American Rolling Mill Co.
Butler, Penna.

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Republic Steel Corporation
Youngstown, Ohio

GEO. S WARREN
Chief Engineer
Sharon Steel Corporation
Sharon, Penna.

Descaling Hot Steel Hydraulically

By J. E. HOLVECK, Sales Engineer,
Worthington Pump & Machinery Corp.,
PITTSBURGH, PA.

Abstract of paper to be presented before the A. I. & S. E. E. Spring Engineering Conference

▲ THE application of water at high velocity has been universally accepted as the best method of removing scale during the process of rolling hot steel. This important progress in the manufacture of various commercial steels, particularly sheet and strip, has resulted in higher quality, more accurate gages, and better surface finish. The benefits derived from this process have been so satisfactory that descaling is being applied to other steel products such as sheet bar, plate, skelp, merchant bar and seamless tubing.

The first consideration in a hydraulic descaling system is a nozzle with the proper shape of orifice which will produce a satisfactory jet, converting the selected available pressure into an efficient impinging force of sufficient magnitude to break the scale.

This impinging force, which is the result of mass and velocity, or water and pressure, first breaks the scale, after which the water, being in continuous contact with the steel, washes the loosened scale off the surface.

J. E. HOLVECK

In the early application of water for descaling, round orifices consisting of small drilled holes in the header pipe, were used. The jet resulting from this orifice was found to produce only about 65% of the impinging force of the well designed nozzle which has little or no contraction and a small amount of friction loss. The round orifice also forms a round jet varying in density from the center to its outer periphery.

Extensive experiments have resulted in an improved nozzle which has, among other features, an elliptical orifice which not only produces a maximum impinging force, but delivers this force uniformly the full length of the jet.

An important factor to be considered in descaling is the cooling effect of the water on the steel. Cooling of the hot steel varies directly as the flow of the jet at the point of contact per inch width of the slab or strip. The increase in pressure to 1000 lbs. was a natural step in descaling since this higher pressure eliminated excessive cooling in the early reduction passes.

It is the intent of this article to offer practical suggestions for the application of nozzles and the use of high pressure water for the satisfactory descaling of hot steel; accepting certain facts already established in a previous article by the writer on this subject (Iron & Steel Engineer August 1931) and proven by experience in existing installations.

Practically all descaling requirements have the same variable water demand characteristics. There may be a few cases where the water demand is constant but these are the exception. In this paper we will consider hydraulic descaling and methods for determining satisfactory equipment for a wide continuous hot strip mill. The same procedure may be followed for any other type of mill by substituting the proper values for determinining the proper equipment.

The variable characteristic water demand is met with either a centrifugal or reciprocating type of pump with an accumulator. The use of an accumulator not only enables the selection of a smaller pump but also provides for a system which maintains a much more uniform pressure.

The hydro-pneumatic type of accumulator has been found most suitable for this service. It consists of a closed pressure vessel charged with two-thirds air and one-third water at 1000 lbs. pressure. Having no moving parts, there is practically no maintenance expense.

The advantages of an accumulator may be briefly stated as follows:

(a) More economical installation from a power standpoint through the selection of a smaller pump.

(b) Provides for practically a constant pressure which is of vital importance.

(c) Provides a means for absorbing shocks to the system produced by the closing of the operating valves.

(d) Reduces the number of times at which a centrifugal pump would operate at shut off.

The Measurement of the Temperatures of Hot Moving Objects

By A. E. KROGH, Sales Engineer
Brown Instrument Company
PHILADELPHIA, PA.

Abstract of paper to be presented before the A. I. & S. E. E. Spring Engineering Conference

▲STEEL men have long been much interested in accurately measuring the temperatures of rapidly moving hot objects such as sheets, rails, bars, billets, rods, tubes, etc., Some of us have in the past tried to do this with contact thermocouples, optical and radiation pyrometers. The results have not been pleasing. Contact thermocouples were much too slow, and subject to innumerable errors. Total radiation pyrometers were also much lagged and were too greatly affected by radiation losses. Manually operated optical pyrometers have heretofore been the best means but they also have been unsatisfactory for the purpose. Human eye fatigue, effects of surrounding light, and the general skill of the operator of the pyrometer combined with the need for speed has introduced errors which, indeed, have sometimes tended to cancel each other— but have on the other hand frequently accumulated to cause extreme errors.

In view of this condition it has been evident that something like an automatic high speed optical pyrometer would be very desirable. Such a unit is now available and it is probably the outstanding pyrometer development of recent years. The rapidity of this pyrometer is apparent from the fact it indicates or records to full scale the temperature of a hot body in about ½ second. Critical damping is inherent and the chart record shows no overshooting.

This device, called the Optimatic, employs photoelectric tubes. In the past there has been much reluctance on the part of mill operators to the use of apparatus incorporating thermionic tubes. The impression has been that such equipment was subject to troubles from vibration, humidity, changes in ambient temperature and rapid aging. Fortunately time and intensive laboratory study have brought superior tubes and exhaustive mill testing has given a clear conception of how to apply them correctly. When properly used, photoelectric and vacum tubes can now be incorporated in simple, rugged and sturdy mill type equipment.

The Optimatic system consists essentially of the Optimatic proper, a power supply and the instrument or instruments. As many instruments as are desired may be connected to any Optimatic system and any one instrument may, by switching means, be used with a number of systems. This permits the installation of relatively low cost indicators for the use of the operators at a number of points on the production line, and these may be used in combination with a recorder which may, at will, be cut in and out of the circuit. Hence, where it is desired to measure temperatures at a number of points along the line, any one of the Optimatic units may be connected to a recorder or several indicators.

Some of the benefits gained through the application of such instruments to hot strip rolling mills are:

1. They render it possible to hold the various slab reheating furnaces at the same temperature because such an instrument is so sensitive that it

A. E. KROGH

detects during the initial stages of rolling the slightest unevenness in heating (even skid marks). Therefore, it becomes the guide for uniform distribution of heat from skid to skid or side to side of the furnaces.

2. Prevents controversies between heaters and rolling mill operators because the record is definite proof of the source of trouble.
3. The best temperature for removal of scale, cleaning and finishing of the sheet can be determined and maintained with it.
4. From an analysis of records the best rolling temperatures for different gauges, sizes, etc., can be determined, enabling exact duplication on subsequent runs.
5. Prevents accumulation of rejects by revealing faulty processing in the early stages, hence it contributes in no small degree to the reduction of manufacturing costs.
6. Makes possible a permanent temperature record of the mill output. This is particularly valuable in the case of alloy steels and for all special orders.

The Optimatic system employs two photocells, connected into a bridge circuit. One of the tubes is exposed to illumination from the hot object while the other is subjected to light from a balancing carbon filament lamp. For the galvanometer usually found in bridge circuits, an amplifying tube is substituted. As the illumination from the hot body varies, the resistance of the photocell exposed to this illumination will change, thus altering the current in the plate circuit of the amplifying tube. This instantaneously increases or decreases the current to the lamp which illuminates the second photocell until the two are again in equilibrium. The lamp current also passes through the instrument galvanometers, the deflections of which are calibrated in terms of temperature.

The general characteristics of the photoelectric cells in the Optimatic are similar. The luminosity-resistance curves need not be identical, but should be parallel. The action in this bridge circuit which causes an increase of current in the amplifying circuit with an increase in light to the viewing photocell will then follow a straight line regardless of any difference in the absolute values of the curves. It is this principle which is absent in thermionic devices which use a single photoelectric tube that gives the Optimatic its stability, nullifies such variations in tube characteristics as may occur during service, and permits wide voltage fluctuations of the mill power supply without creating erroneous temperature indications.

Detailed records from applications of this device to rolling mill operation are available, illustrating the performance and speed of the instrument. These will be explained in combination with a series of views to be presented at the Youngstown Conference.

M. STONE

Control and Recording of Rolling Mill Pressures

By M. STONE, Engineer,
United Engineering and Foundry Co.,
PITTSBURGH, PA.

▲ONE of the most important factors in the development of the rolling process has been a correct appreciation of the variables affecting the magnitude of the rolling pressure. This has manifested itself particularly in wide strip mills and for lighter gauges where a proper control of such factors, together with a protection of the bearings against overload, desirable maintenance of constant pressure during rolling, proper settings of both screws of the mill, etc., are important.

In order to make these things possible, a Roll Pressure Meter has been developed which utilizes the strain in the housing posts to indicate the magnitude of the rolling load. By the proper adaptation of an electromagnetic strain gauge embedded in the housing, both remote indication and recording of rolling mill loads have been worked out to a practical success. At the present time, some dozen mills have been equipped with such apparatus and it is the aim of this paper to describe the instrument, its utility and applications.

Tension Control in Cold Strip Rolling

By F. MOHLER, Industrial Eng. Dept.,
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▲ TENSION plays such an important part in modern cold strip rolling that some consideration of its control and the problems involved is certainly warranted. The scientific study of its effects and the perfection of its control may be the answer to many of the perplexing problems confronting you at present. Undoubtedly it will play a stellar role in the quest for higher rolling speeds, better gage accuracy and greater production of fine quality strip.

With the rolling of wider strips and the taking of heavier reductions, tension has become essential to maintaining a flat smooth strip. The reversing cold strip mill has already taught considerable in regard to the possibilities of tension control. This mill forms an excellent proving ground because both front and back tension can be varied independently and over a wide range. This mill has illustrated conclusively that much can be done in at least partially compensating for defects in roll shape, lubrication, housing stretch, etc., by properly manipulating the tensions. As a result its importance and necessity is pretty generally accepted at present.

F. MOHLER

TENSION CONTROL FOR REELS

The usual tension reel control consists of a regulator which maintains a constant armature current by controlling the field of its driving motor and slowing it down as the coil builds up. In order to maintain constant armature current the field must be strengthened in exactly the same ratio as the radius of the coil increases. Since the torque of a motor is proportional to the product of armature current and field strength, this means that the torque increases with the radius of this coil and, therefore, constant tension is maintained.

The question is frequently asked as to how much range of tension control can be obtained. The usual answer is from 20 to 100 per cent. The regulators will hold any current down to practically zero. However, it is very misleading to say that zero, or even 10 per cent, tension can be maintained. The friction and motor losses are probably in the neighborhood of 10 per cent rated load. Thus, when the regulator is holding 10 per cent current, that available for tension is zero. Suppose that we even hold 15 per cent current so as to obtain 5 per cent for tension. It is obvious that a very small change in friction load or in motor losses represents a large percentage change in tension.

TENSION CONTROL BETWEEN TANDEM STANDS

Constant current regulators are also frequently used for maintaining a "constant tension" between stands. Offhand it might appear that the same method of control as used for reels is equally applicable to tandem mills. However, there is a vast difference in the effectiveness of the tension control in these two cases.

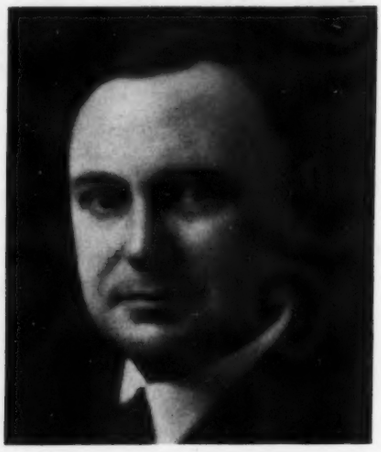
In the tension reel drive the entire current input to the motor, less the relatively small portion consisting of motor losses and that used in overcoming friction, goes into tension in the strip. However, the current input to the main drive of a tandem mill goes largely into that required by the rolling load, and only a small portion goes into tension. This may be of the order of 90 per cent for rolling load, and 10 per cent for tension. The regulator can not differentiate between rolling load and tension load, and all it can do is to maintain total current input. Suppose the rolling load increases 10 per cent, then that left for tension becomes zero. Or suppose it decreases 10 per cent, then the tension becomes 20 per cent. In both of these cases the tension has varied 100 per cent.

Compound motors, series exciters, and line resistors have all been used, but have in general been discarded. It is obvious that all of these attempt in a less degree to do the same as the current regulator does—i.e., slow down the motor on an increase in current in an attempt to maintain a constant input.

Thus the only way tension can be maintained constant between stands is to increase the tension itself and use this measurement for operating the regulator. A device has been perfected for this purpose, and is in successful operation on the new tandem cold strip mill of the Ford Motor Company.

(Please turn to page 14)

Committee on Arrangements



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Tension Control in Cold Strip Rolling

(Continued from page 13)

The device consists of an accurately ground roll, equipped with self aligning anti-friction bearings, each of which is resiliently supported by a pedestal. This is preferably mounted midway between stands and a few inches above the pass line. The strip passes over the roller and presses downward. A small pressure on the roll represents a high tension in the strip.

Any deflection of the roll operates a very sensitive air gap transformer which produces a current proportional to the deflection and, therefore, the tension. This is exactly the same principle used in the extremely accurate Electrolimit continuous gage.

For wide mills a pressure detector is placed under each bearing. The sum of the currents from these two detectors represent the total tension which is indicated by an instrument calibrated directly in pounds. This sum is also used to operate the regulator directly. The difference in the currents from these two detectors indicates the difference in tension between the two edges of the strip by means for a zero center instrument calibrated directly in pounds.

Even through regulators are not used this equipment eliminates guesswork, and enables the operator to control not only the tension between stands manually and accurately, but to keep the mills level.

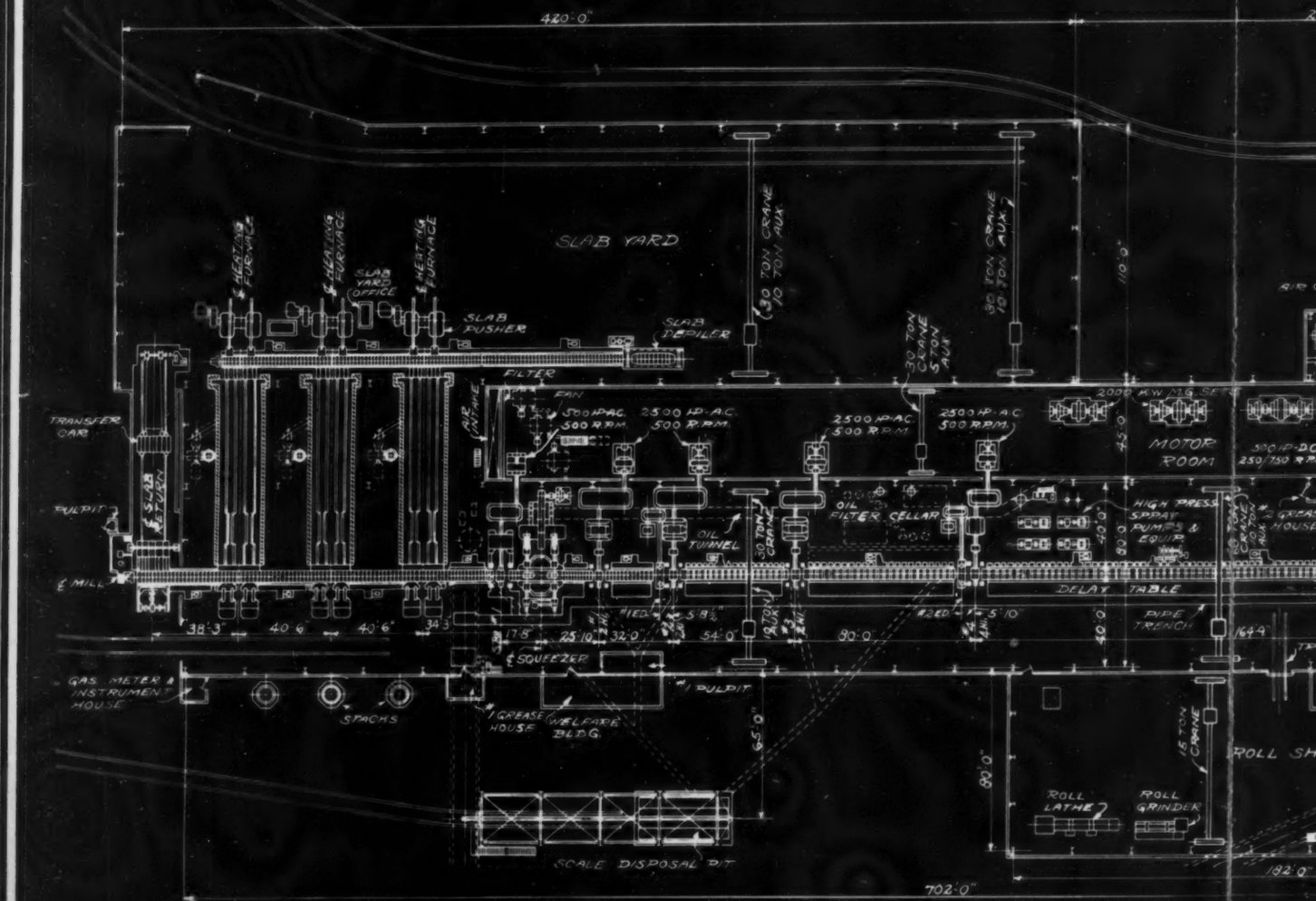
OPERATION AT REDUCED VOLTAGES

The effectiveness of tension control is materially reduced at low operating voltages because a proportionately greater range of motor field control is required. This handicap can be overcome to a large extent by a wise choice of armature resistance and by using booster generators.

ARMATURE RESISTANCE AND INERTIA

A great deal can be done in obtaining better tension control by properly relating the armature resistance and its inertia. However, this does not cure all of the evils because the motors may operate at different points in their speed ranges for different rolling schedules. Much can be done to help this situation in the proper selection of gear ratios.

Automatic gage control and new type regulators will also be discussed in the complete paper.


420'-0"
SLAB YARD
HEATING FURNACE
HEATING FURNACE
SLAB YARD OFFICE
HEATING FURNACE
SLAB PUSHER
SLAB DEPILER
30 TON CRANE 10 TON AUX
30 TON CRANE 10 TON AUX
110'-0"
FILTER
FAN
AIR ENTRANCE
2500 H.P. A.C. 500 R.P.M.
2500 H.P. A.C. 500 R.P.M.
2500 H.P. A.C. 500 R.P.M.
2500 H.P. A.C. 500 R.P.M.
2000 K.W. M.G. SET
MOTOR ROOM
45'-0"
TRANSFER CAR
SLAB RETURN
PULPIT
OIL TUNNEL
OIL FILTER CELLAR
30 TON CRANE
HIGH PRESS SPRAY PUMPS & EQUIP.
30'-0"
30'-0"
30 TON CRANE 10 TON AUX
GREASE HOUSE
MILL
DELAY TABLE
38'-3"
40'-6"
40'-6"
34'-3"
17'-8"
25'-10"
32'-9"
54'-0"
90'-0"
42"ED
5'-10"
PIPE TRENCH
164'-9"
SQUEEZER
#1 PULPIT
GAS METER & INSTRUMENT HOUSE
STACKS
#1 GREASE HOUSE
WELFARE BLDG.
65'-0"
80'-0"
15 TON CRANE
ROLL SH
ROLL LATHE
ROLL GRINDER
SCALE DISPOSAL PIT
182'-0"
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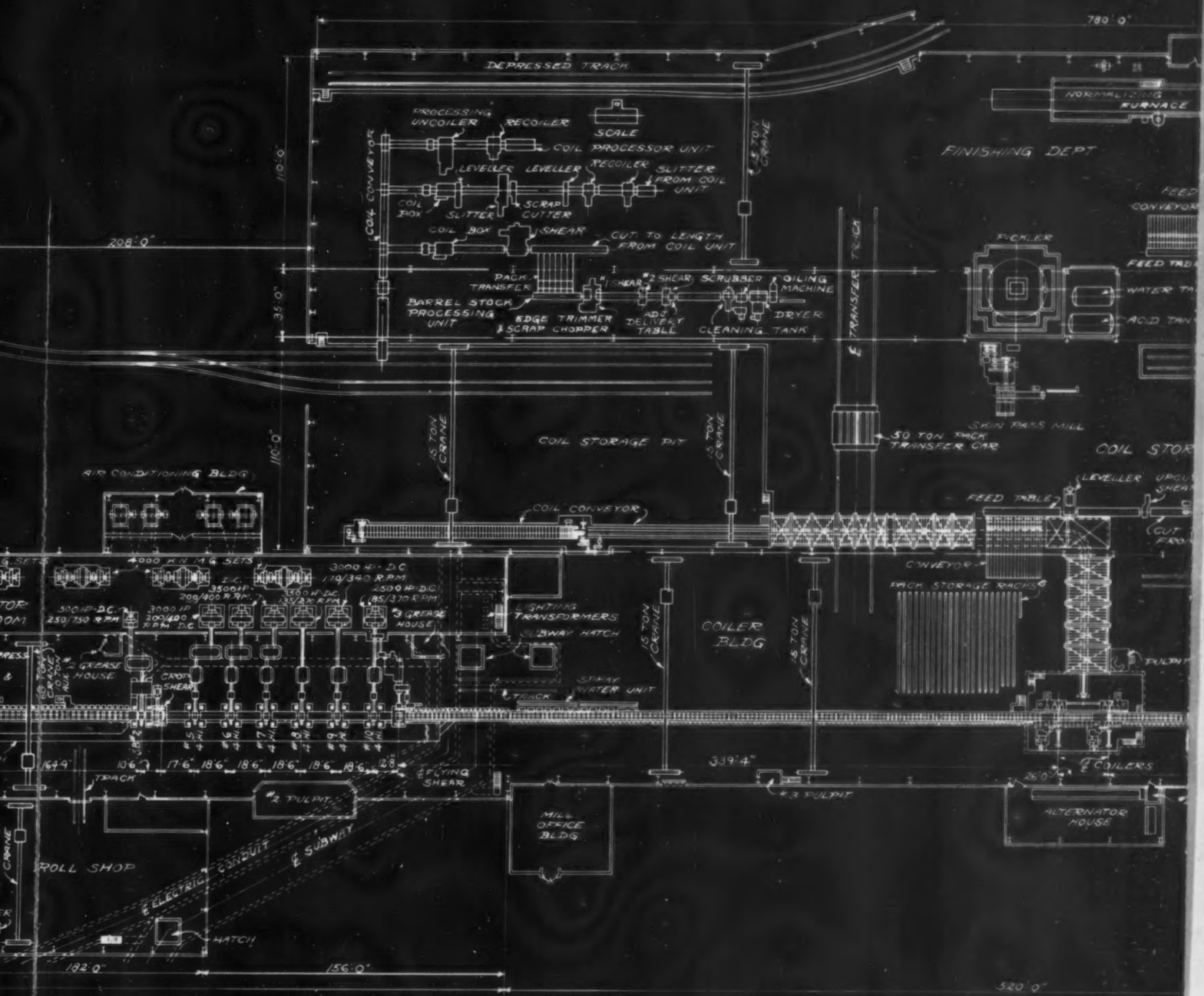
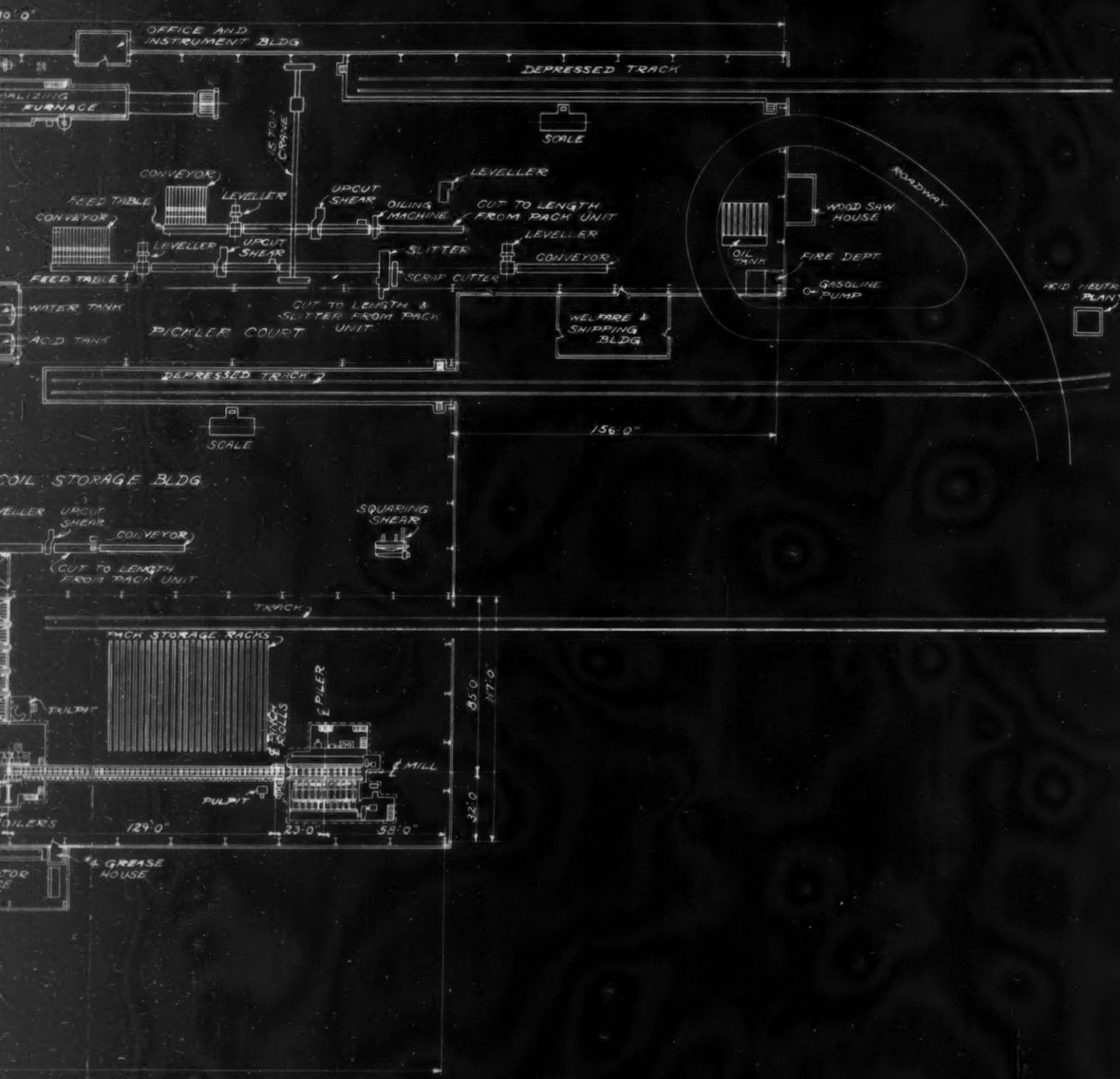


PLAN VIEW - 43" CONTINUOUS HOT STRIP MILL

NEGIE-ILLINOIS STEEL CORPORATION - McDONALD



MILL

ALD, OHIO

CARNEGIE - ILLINOIS STEEL CORP.

NEW HOT STRIP MILL AT McDONALD, OHIO

By JOHN KELLY, JR.
Associate Editor

Distinctive Engineering Features of this New Installation

▲ THE members and guests of the A. I. & S. E. E. will have an opportunity of viewing a striking example of the fruits of modern engineering skill and development upon the occasion of their inspection trip to the Carnegie-Illinois Steel Corporation's new 43" continuous hot strip mill on Thursday afternoon, April 23, in conjunction with the Spring Engineering Conference.

This mill is located at McDonald, Ohio. It covers an area of approximately 8 acres and has been in operation since December, 1935, increasing the finished hot rolled steel capacity of the Carnegie-Illinois Corporation plants in the Youngstown district by some 360,000 tons annually.

Several novel and unique features have been incorporated in the design and operation of the plant, and among these is the strikingly large amount of power applied in driving the main mill stands, permitting production of the heaviest coil per inch of width at the highest finishing speed (2000 feet per minute) ever attained on a continuous strip mill.

The material produced is quality strip steel, rolled to close tolerances in widths from 12 to 37 inches and ranging in thickness from No. 18 gauge to $\frac{3}{8}$ inch in thickness. The product is delivered either as coils weighing up to 300 pounds per inch of width with a maximum thickness of $\frac{1}{4}$ inch, or in cut lengths varying from 30 inches to 30 feet, with a maximum thickness of $\frac{3}{8}$ inch. By utilization of coiling and sheet slitting equipment, stock may be furnished in any desired width from $4\frac{1}{2}$ inches to 37 inches.

Power for operation is supplied from the generators of the Carnegie-Illinois Steel Corporation's Ohio Works, being stepped up from 6600 volts to 44,000 volts and transmitted seven miles by high tension lines to McDonald where it is stepped down to 6600, 220 and 110 volts, A.C., and converted in part to 600 and 250 volts, D.C. This power is applied principally for operation of the mill's 765 motors ranging from $\frac{1}{4}$ to 3500 H.P. and which require approximately 600,000 cubic feet of cleaned cooling air per minute.

L. N. McDONALD
General Superintendent

SLABS

Semi-finished steel for the mill is received from the Ohio Works of the Carnegie-Illinois Steel Corporation in the form of slabs, the strip mill being designed to handle a slab of maximum size of $6\frac{1}{4}$ inches thick, 39 inches wide, and 16 feet long, and maximum weight 13,000 pounds. The mill is designed to roll a wide variety of compositions, including ordinary low and medium carbon steels, Ply-Krome, Cor-Ten, Man-Ten, Low Metalloid, and 18-8 Stainless. The slabs are delivered by rail to a storage yard located at the northern end of the mill property, adjacent to that section of the plant housing the heating furnaces. The yard proper is 420 feet long and 110 feet wide and has a capacity for 12,000 tons of steel. The slabs are unloaded by two 30-ton overhead cranes and stored, these same cranes also being used for placing the slabs upon the depiler.

The depiling unit is driven by two mill type motors; the first, a 75 H.P., 500 R.P.M., 250 volt motor is employed for driving the elevating mechanism, and the other, a 25 H.P., 650 R.P.M. motor operates the conveying mechanism which places the slabs on the furnace entry table, preliminary to delivery to the heating furnaces.

This entry table for conveying the slabs to the heating furnaces is of heavy duty construction, 175 feet, 6 inches long, and is driven by four 25 H.P., 650 R.P.M., 250 volt mill type motors. It transports material at a speed of 268 feet per minute.

Following their transfer over this table to the entry end of the

Storage yard for slabs. On the left may be seen the entry table for conveying the slabs to the heating furnaces. This table has a speed of 268 feet per minute.

Shown above are the three heating furnaces which have a heating capacity of 50 gross tons of slabs per hour each. Hearth dimensions for each furnace are 18′×75′.

furnaces, the slabs are charged by means of ram type, motor driven pushers, each of the furnaces being serviced by an individual pusher which is driven by a 100 H.P., 475 R.P.M., 250 volt direct current mill type motor. An observation pulpit is provided between the pushers of No. 2 and No. 3 furnaces to facilitate operation.

HEATING FURNACES AND CONTROL

Each of the three heating furnaces has a capacity of 50 gross tons of slabs per hour, heated from cold to rolling temperature, and is designed to heat slabs varying in dimensions from 12 to 39 inches wide, from 3 inches to 6¼ inches thick, and from 5 feet to 16 feet long. Hearth dimensions for each furnace are 18 feet by 75 feet.

These furnaces are of the zone controlled, triple fired, end charged and end discharged type. This type of furnace is divided into three zones, in each of which the temperature of the slab is progressively raised, until, in the third zone, the slab has attained the proper rolling temperature throughout its cross section, insuring homogeneity in the finished product without any danger of overheating. Such furnaces may be successfully operated with varying tonnages and have a relatively high efficiency inasmuch as they permit full advantage being taken to the maximum flame temperature available in the primary heating zone. Another advantage of this method of firing is the elimination of excessive scale loss, regardless of whether the furnaces are operating at full or low capacity.

The furnace discharge doors, operated by electrically driven mechanism, are designed to give minimum heat losses, and are kept closed at all times except during the short periods in which a heated slab is discharged.

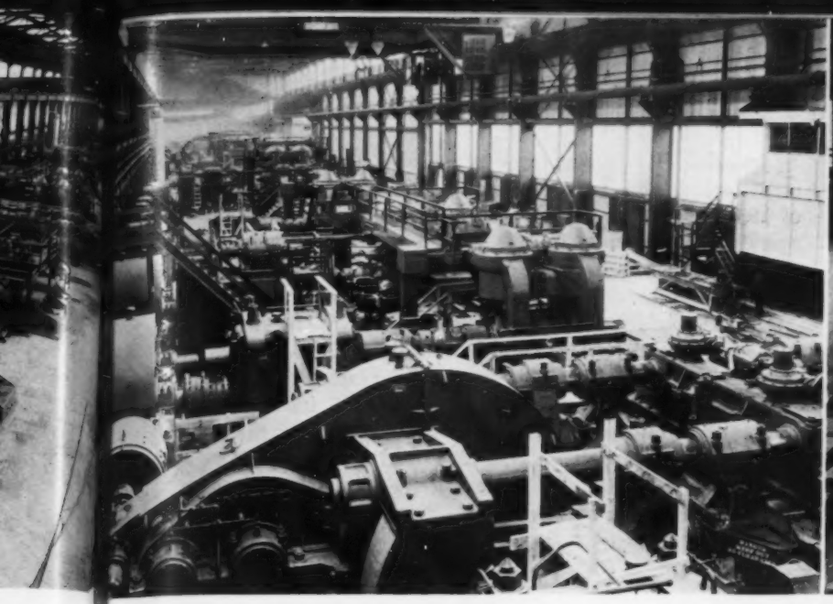
Air for combustion is preheated in individual tubular recuperators. Preheated air is drawn from these recuperators by high temperature exhaust fans and delivered to the burners under a pressure of from 2 to 2½ inches. The furnaces are natural gas fired, and provisions have been made for the optional use of either fuel oil or tar at some future date. When heating 50 gross tons of steel per hour (i. e., full capacity) and charging either a double row of 8 feet slabs or a single row of 16 feet slabs, the fuel consumption is approximately 1,650,000 B.T.U. per gross ton of steel heated.

Each furnace is equipped with an individual control panel on which is mounted meters calibrated in standard units of flow, pressure, and air: fuel ratio. The control units and instruments included on each panel are as follows:

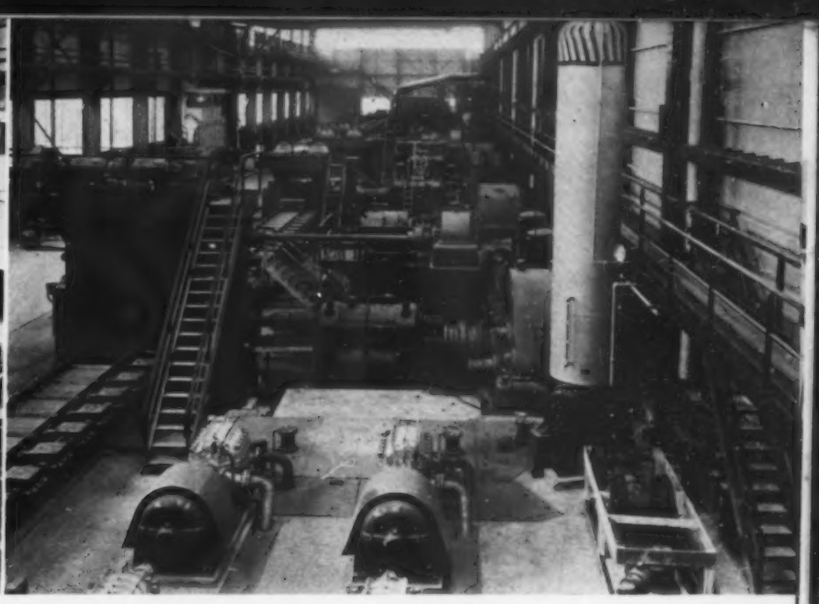
1 Gas pressure regulator
1 Furnace pressure regulator for controlling the stack damper
3 Complete combustion controls, one for each zone
3 Gas flow indicators, indicating the gas flow to each zone
1 Totalizing gas flow meter, recording the total gas used in each furnace
1 Furnace pressure recorder
1 CO_2 recorder
1 Three point temperature recorder for recording the temperature of stack gases, preheated air, and waste gas entering the recuperator.

In addition, hand wheels for the control of gas flow to each zone are mounted on the front of the panels, and, in this manner, the entire furnace manipulation is centralized at the control panels.

The combustion control indicators mentioned above are so calibrated that the percentage air: fuel ratio may be controlled in each individual zone. All control units and instruments are mounted behind the panels, so



General view showing mill proper with slab squeezer in foreground. Designed to operate at five squeezing strokes per minute, this machine is capable of, with a single stroke, affecting a 3 inch reduction in width upon a slab of maximum thickness (6¼ inches).



Shown here is the first stand of the roughing train. It is (as are, also roughing stands No. 2 and No. 3) of the two high type with rolls 32 inches in diameter by 43 inches long.

that only the manipulating handwheels, meter dials, and charts are visible from the front.

Having attained the proper rolling temperature in an equalized manner throughout their cross-section, the slabs are discharged from the furnace on to the furnace delivery table. Immediately across this table, and facing the furnace discharge doors, are six bumpers (two for each furnace) for bearing the impact of the slabs as they are ejected. These units operate on friction draft gear and are entirely independent of the delivery table proper.

The table rollers are manufactured of forged steel, their centers being spaced at a distance of 27 inches apart. They are driven by two 35 H.P., 575 R.P.M., 250 volt, D.C., mill type motors and deliver the slab to the first mill stand at a speed of 208 feet per minute.

In the event the mill cannot accommodate the slab, the table is reversed and the slab taken to a return table located at the far end of the furnace floor. This table is driven by a 35 H.P., 650 R.P.M., 250 volt, mill type motor. It is equipped with an overload pusher by means of which the hot slab is moved on to a set of cast iron skids and deposited in a specially designed transfer car which carries the slab to a point accessible to the overhead cranes in the slab storage yard. The returned slab is then lifted out and stored for future use.

NO. 1 ROUGHING SCALE BREAKER

Upon reaching the first mill stand, located at a distance of 34 feet, 3 inches from the closest furnace and 115 feet, 3 inches from the farthest one, the slab is given a very light reduction to remove the scale which has accumulated in the furnace. This stand is of the two-high type with rolls 26 inches in diameter by 50 inches long. It is driven by a 500 H.P., 500 R.P.M., 6600 volt, 25 cycle motor, the mill speed being 198 feet per minute. This light pass, together with the action of hydraulic sprays, forcing water against the slab at a pressure of 1000 pounds, effectively remove the scale which is then washed into a trough under the mill and carried by gravity to the scale disposal pit.

SLAB SQUEEZER

Having passed through the descaling operation, the slab is conveyed along the mill line to the squeezer, 17 feet, 8 inches ahead (center line distance). This machine is designed to operate at five squeezing strokes per minute and is capable of effecting, with a single stroke, a 3 inch reduction in width upon a slab of maximum thickness (6¼ inches). The squeezer is driven by a 700 H.P., 500 R.P.M., 230 volt, D.C. motor. The side guards and screwdowns are motor operated and electrical indicating devices permitting micrometer adjustment have been provided. (These features of manually operated, close-controlled power adjustments are common to all other reduction stands as well as to the slab squeezer.) For nominal changes of width, this squeezer will eliminate the necessity for carrying large slab stocks of various widths, and also aids in straightening.

ROUGHING TRAIN

The first stand of the roughing train is 25 feet, 10 inches from the squeezer. It is (as are, also, roughing stands No. 2 and No. 3) of the two-high type with rolls 32 inches in diameter by 43 inches long. Each of these three stands is driven by a 2500 H.P., 500 R.P.M.,

Finishing scale breaker equipped with rolls of the 2 high type, 28″ in diameter by 43″ long. Crop shear also shown is utilized to remove chilled crop ends.

25 cycle, 6600 volt motor through a double reduction gear unit, the first two stands operating at a mill speed of 216 feet per minute and the third at a speed of 330 feet per minute. Roll necks are mounted in water lubricated fabric bearings, and the housings are designed for replacement with grease lubricated bronze bearings if, and when, desired. Each stand is provided with hydraulic sprays of 1000 pounds pressure. The three stands are spaced as follows: Between No. 1 and No. 2, 32 feet; between No. 2 and No. 3, 54 feet. The conveying table between stands No. 1 and No. 2 operates at a speed of from 106 to 212 feet per minute; that between stands No. 2 and No. 3 operates at from 167 to 334 feet per minute. Each section of the table is driven by a 25 H.P., 650/1300 R.P.M., 250 volt, D.C. motor.

An edging stand with 24 inch vertical rolls is located ahead of stand No. 2, its purpose being the control of slab widths. This stand is driven by a 200 H.P., 400/900 R.P.M., 250 volt, direct mill type motor. It has a roll speed varying from 88 to 209 feet per minute. Provision has been made for future installation of a similar unit before stand No. 3, if so desired.

Passing through No. 3 roughing stand the elongated slab is conveyed to the second edging stand, a distance of 74 feet, 2 inches, the conveying table having a speed of 195 to 390 feet per minute. The edger, driven by a 200 H.P., 400/900 R.P.M., 250 volt, direct current mill type motor, operates at speeds from 176 to 418 feet per minute.

Directly beyond No. 2 edging stand (5 feet, 10 inches) the slab enters No. 4 roughing stand. This stand (identical with the six finishing stands) is of the four-high type, with rolls 21 and 45 inches in diameter by 43 inches long. It is, as the other three roughing stands, driven by a 2500 H.P., 500 R.P.M., 25 cycle, 6600 volt motor, the roll speed for the stand being 430 feet per minute.

H. L. BRINDLE
Assistant General Superintendent

DELAY TABLE

After completion of the roughing operation the slab passes on to a delay table which is 164 feet, 9 inches long and operates at a speed of 105 to 422 feet per minute. The table is equipped with an especially designed rocking device which is driven by a 5 H.P., 1025/2000 R.P.M., 250 volt, D.C., mill type motor. Temperature measurements are made upon the steel by means of a rapidly read radiation pyrometer, and the steel is held on the table until it has cooled to the proper finishing temperature. In the design of this table, provisions have been made for the installation of an air blast system for more rapid cooling, if it is desired.

H. J. BAUGH
Assistant General Superintendent in Charge of Production.

Mr. Baugh is also Gen. Chairman of A. I. & S. E. E. Spring Engineering Conference.

FINISHING SCALE BREAKER AND CROP SHEAR

The proper temperature having been reached, the steel advances to the finishing scale breaker in which all adherent mill scale is removed. This stand is of the two-high type, equipped with rolls 28 inches in diameter and 43 inches long, operating at mill speeds of from 103 to 310 feet per minute. It is driven by a 500 H.P., 250 to 750 R.P.M., 230 volt, D.C. motor and is also equipped with a hydraulic spray system similar to those installed on the roughing train.

At this point in the process the steel passes to a flying crop shear which removes the chilled end of the strip, thus eliminating the possibility of marking the work rolls of the finishing train. This shear is of the double crank type and the knife alignment is controlled by means of a hand wheel. The point at which the cut is made is determined by means of an electronic timer, and operation is either automatic or manually controlled from an operator's desk, located on the mill floor. The shear, driven by a 75 H.P., 600 volt, mill type motor, is capable of cutting steel of dimensions up to $\frac{7}{8}$ inch thick and 37 inches wide. After cutting, the cropped ends fall into a box located below the shear. Whenever necessary, this box may be moved, by means of a hydraulic cylinder provided for the purpose, to a point accessible to the overhead crane.

W. D. GRIFFITH
Superintendent
Bar and Hoop Mills

FINISHING TRAIN

Having been freed of all scale and cropped, the strip passes to the finishing train, the first stand of which is located 17 feet, 6 inches beyond the crop shear. The train consists of six four-high stands (identical with No. 4 roughing stand) having rolls 21 and 45 inches in diameter and 43 inches long. All stands are equally spaced at a distance of 18 feet, 6 inches between centers. Data of drives for these units are given in Table I. All roll necks on the finishing train

CHARACTERISTICS OF MOTORS APPLIED TO FINISHING TRAIN

TABLE I

Stand No.	Motor H.P.	Speed	Voltage	Drive	Rated Roll Speed
1	3000	200/400	600	Geared	199/398
2	3500	200/400	600	Geared	393/786
3	3500	200/400	600	Geared	561/1122
4	3500	135/220	600	Direct	744/1488
5	3000	170/340	600	Direct	946/1892
6	2500	185/370	600	Direct	1017/2035

Finishing train of 6 stands of the 4 high type, anti-friction bearing equipped. These stands have rolls 21″ x 45″ x 43″ and the stands are equally spaced 18′ 6″.

have tapered roller bearings as does, also, the four-high roughing stand. Loopers and pullbacks are provided between each of the finishing stands, the former being driven by individual 35 H.P., 575 R.P.M., 250 volt, direct mill type motors.

FLYING SHEAR

After leaving the finishing mill the strip passes through a flying shear capable of cutting lengths of from 10 to 30 feet graduated over $\frac{1}{8}$ inch increments. This shear is geared to the last mill stand and is also powered by a 100 H.P., 300/1000 R.P.M., 600 volt, direct current mill type motor and operates at 1000 to 2200 feet per minute.

RUNOUT TABLE

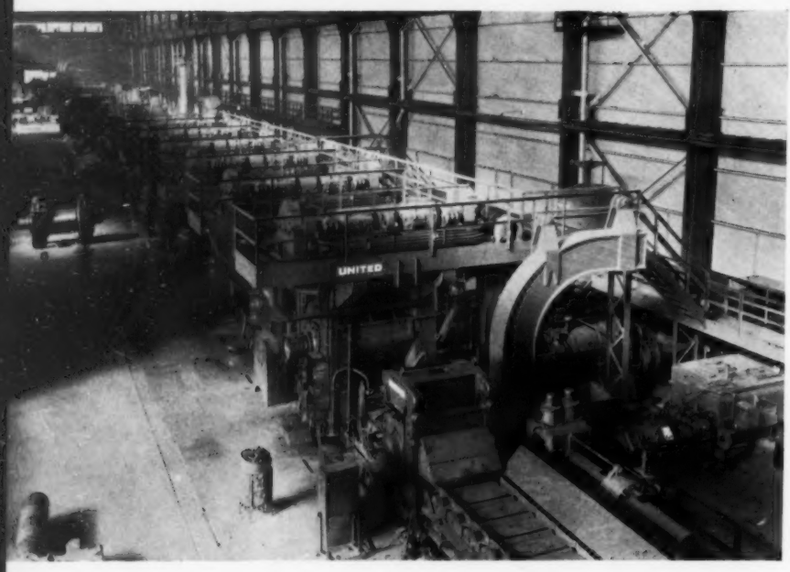
From the shears the material proceeds over the coiler runout table, 365 feet in length, composed of rollers 42 inches in length by 10 inches in diameter,

HOWARD LINN
Superintendent
of the mill.

spaced on 24 inch centers. Each roller is individually driven through a flexible coupling by a 12 pound-foot torque, 900/300 R.P.M., 440/147 volt, 60/20 cycle, A.C. motor, and the table proper has a transporting speed of 785 to 2356 feet per minute. Shortly after it passes to the runout table the steel advances through a water spray unit approximately 100 feet in length, providing water cooling facilities from both above and below.

COILERS AND CONVEYORS

Passing through the spraying unit, the strip continues along the same table to two hot coiling machines



Another view of the finishing train showing the flying shear which furnishes cut to length stock 10 to 30 feet long in increments of 1/8".

capable of handling the material at maximum production rate (2000 feet per minute). These coilers have a maximum diameter when full open of 60 inches, the inside of coil being a constant diameter of 30 inches; coil widths range from 12 to 37 inches, with weights up to 11000 pounds. Each unit is provided with a pneumatic ram for pushing the coils from the reel into a transfer car, whence they are transferred to a chain conveyor which advances them to a right angle gravity turn and on to another chain conveyor which carries them through a tunnel under the finishing department over a set of recording scales and on to a pallet conveyor into the coil storage room. From here they are either loaded into cars for direct shipment or placed on another conveyor system serving the three coil processing units which will be described below.

Material for piling is conveyed from the mill to a point beyond the coilers on to a piler runout table, 129 feet in length, to a sheet piler. This runout table is identical in design and operating speed with the coiler runout table; the rollers, however, are driven by 26 lb.— ft. torque motors, of otherwise similar rating as those mentioned above. The material is fed to the piler through a set of pinch rolls, directly driven by a 15 H.P., 400/1600 R.P.M. motor, and so designed as to allow for wide variations in sheet dimensions.

The piling mechanism consists of a connected series of horizontal cast iron plates which may be elevated and lowered, and adjustable side guards to collect the stack. The lifting opparatus is operated by a 100 H.P., 300/1000 R.P.M. D. C. mill type motor; power for side guard adjustment is supplied by a 10 H.P., 800 R.P.M., D. C. mill type motor. As each pack is completed the piler is lowered and the pack is transferred by a chain conveyor to an automatic scale, thence to the hot pack storage rack, located in the Coiler Building nearby, where it is allowed to cool. It is then either shipped out unprocessed or transported by conveyor or transfer car to one of the three cut to length pack processing units.

As stated above, the coil finishing department of the McDonald plant is divided into three processing units. These are: (1) the cut to length from coil unit; (2) the slitter from coil unit; and (3) the coil processor unit. In the first, the strip is uncoiled and passed through a leveller for flattening. It is then cut to length in a flying shear capable of cutting material up to ¼ inch thick to close tolerances at speeds ranging from 100 to 300 feet per minute. In the slitter from coil unit the strip is uncoiled and passed through a five roll leveller, then transferred to a slitter which is capable of cutting as high as seven widths simultaneously, waste from the operation being reduced in a scrap cutting machine to sizes convenient for handling. After slitting the strip is passed through a leveller and recoiled, two recoilers being provided for the purpose. In the coil processing unit, the coil is unwound and processed to prevent coil breaks, fluting, etc. The processed strip is passed through a five-roll leveller and goes to a three-roll recoiler. The products of all three of these finishing units are discharged in a position easily accessible to the overhead crane which services the coil processing department. This crane transfers the finished material either to another of the processing units or to stock or railroad cars.

The pack finishing department is also comprised of three processing lines. The first of these, fed by a tilting table, is used only for black cut-to-length stock. It consists of a 17-roll leveller for flattening and an up-cut shear. Packs which are neither shipped nor process in the first cut-to-length from pack unit are transferred by a 50 ton electric pack transfer car. There are two other cut-to-length finishing lines in addition to the one described immediately above. One of these, for cut-to-length finished material consists of a leveller and an up-cut shear. The other, a cut-to-length and slitting unit, contains a leveller, up-cut shear, slitter, scrap cutter and final leveller, respectively. The slitter and scrap cutter in this unit are similar to the ones included in the coil slitting line,

View of run out table showing individually driven rollers and sprays for cooling. Each roller is equipped with 12 pound-foot torque motors. The table speed varies from 785 to 2356 feet per minute.

described above. These two units are capable of handling stock from No. 18 gauge to ¼ inch thickness, giving a flat product cut to close tolerances. All lines are supplied by a conveyor and feed table system, and the finished product is easily available to the 15 ton overhead crane which serves the department.

Auxiliary processing equipment includes a 156 inch squaring shear which is capable of handling material in thicknesses up to ⅜ inch for surface finishing, a two-high skin pass mill with rolls 28 inches in diameter by 48 inches long and possessing a roll speed of 120 to 360 feet per minute; a four arm batch pickling unit capable of accommodating cut material up to 20 feet in length; and a continuous natural gas fired normalizing furnace, 85 feet long by 9 feet, 7 inches wide.

LUBRICATION

The fifteen lubrication circuits in the mill are supplied by four conveniently located grease houses. All anti-friction bearings on roll necks (the roughing train roll necks employ composition bearings), tables, screwdowns, etc. (a total of 2700 points, movable and stationary) are lubricated with grease, the systems being either wholly automatic (time clock control) or semi-automatic (switch control). Anti-friction bearings on gear drives, pinion stands, etc., are lubricated by two continuous circulating oil systems, each system having a capacity of 325 gallons per minute and drawing its supply from an individual 7500 gallon storage tank, supplied with automatic temperature control. The pinion bearings require an oil of 2400-2600 viscosity (100° F.), and gear drive bearings require one of 1600-1800 viscosity (100° F.), both being supplied at 35 to 40 pounds pressure. All oil is pressure filtered before it is returned to the supply tanks. All lubricating circuits are supplied with indicators and alarms as a precaution against any failures in the supply lines.

MOTOR ROOM

A large motor room, 572 feet long and 45 feet wide, houses the mill's main motors, motor-generator sets and switchboards. 600,000 cubic feet of conditioned air are supplied per minute by fans and filters located in a small adjoining building. The cleaned air enters the room through ducts provided with motor driven fans. The heated air is drawn off by motor driven ventilators in the roof. The room is serviced by a 30 ton crane. Contained in the room are: three 4000 kilowatt and two 2000 kilowatt motor-generator sets; three 3500 H.P., two 3000 H.P., five 2500 H.P., and two 500 H.P. motors, all of which are used for operating the mill stands.

A roll shop, 80 feet wide by 182 feet long, equipped with roll lathe, roll grinder, and a 15 ton overhead crane provides the necessary machining and storage facilities.

View of three processing lines showing coils being transported from coil storage department to finishing department.

A. R. SCHULZE
Chief Mechanical Engineer

ROBERT BACKUS
Master Mechanic

The buildings are equipped with twelve modern electric overhead traveling cranes, ranging in capacity from 15 to 60 tons and distributed throughout the plant as shown in Table II.

TABLE II

Location	Capacity	Number
Strip Mill	60 tons	1
Strip Mill	30 tons	1
Slab Yard	30 tons	2
Motor Room	30 tons	1
Coil Storage Room	15 tons	2
Coiler Building	15 tons	2
Finishing Department	15 tons	2
Roll Shop	15 tons	1

WELFARE

The engineers and executives of the Carnegie-Illinois Steel Corporation may feel justly proud of their efforts to provide the best conditions for the workmen.

Welfare buildings of all steel insulated construction contain all the necessary facilities. Fountains dispensing cooled drinking water are located at convenient spots throughout the mill. Overhead individual steam heaters in finishing departments provide comfortable working conditions during cold weather. Adequate natural lighting is provided through 38,000 square feet of skylight and 63,000 square feet of windows. An intensive survey was made when the buildings were erected to select the best artificial lighting facilities. Forty-six large ventilators insure from 1½ to 6 complete changes of air per hour.

EQUIPMENT AND MANUFACTURERS

Contained in the following summary is a list of the principal equipment for this mill and the manufacturers of same.

AIR FILTERS
Independent Air Filter Co.

THOMAS BACKUS
Assistant Master Mechanic

THOMAS B. McELRAY
Superintendent of Electrical Dept.

BEARINGS (Roll Neck)
Timken Roller Bearing Co.
Bantam Ball Bearing Co.
SKF Industries, Inc.

BEARINGS (Tables and Drives)
Rollway Bearing Co., Inc.
Hyatt Roller Bearing Co.
Timken Roller Bearing Co.
Messinger Bearing Co.

BOILER
Babcock-Wilcox Co.

BUILDINGS (Steel)
American Bridge Co.
H. H. Robertson Co.
Detroit Steel Products Corp.

CIRCUIT BREAKERS (AC)
Westinghouse Electric & Mfg. Co.

CIRCUIT BREAKERS (DC)
I-T-E Circuit Breaker Co.

CLUTCHES (Magnetic)
Dings Magnetic Separator Co.
Cutler-Hammer, Inc.

CONVEYING SYSTEM
Mathews Conveyor Co.
Jeffrey Manufacturing Co.

COUPLINGS (Flexible)
Bartlett-Hayward Co.

CRANES (Electric)
Morgan Engineering Co.
Whiting Corp.
Shaw Box Crane & Hoist Co.
Harnischfeger Corp.
Alliance Machine Co.

ELECTRICAL EQUIPMENT
Westinghouse Electric & Mfg. Co.
General Electric Co.
Clark Controller Co.
Electric Controller & Mfg. Co.
Reliance Electric & Engineering Co.
Crocker-Wheeler Electric Mfg. Co.
Cutler-Hammer, Inc.
Lincoln Electric Co.
Electro Dynamic Co.

FANS (Furnace)
B. F. Sturtevant Co.

FANS (Filter)
American Blower Co.
B. F. Sturtevant Co.

FURNACES (Normalizing)
Swindell Dresser Co.

FURNACES (Slab Heating)
Rust Furnace Co.

FURNACES (Slab Heating Control)
Askania Regulator Co.

L. M. APPLEGATE
Chief
Civil Engineer

INSTRUMENTS (Indicating & Recording)
Brown Instrument Co.
Foxboro Co.
Leeds & Northrup Co.

INSULATORS
Lapp Insulator Co.

LEVELLER (Roller)
Aetna Standard Engineering Co.
McKay Machine Co.

LUBRICATING SYSTEM
Trabon Engineering Co.
S. F. Bowser Co.

MILL EQUIPMENT
United Engineering & Foundry Co.

PICKLING MACHINE
Mesta Machine Co.

PUMPS (Hydraulic Spray System)
Wilson-Snyder Co.

ROLL GRINDER
Farrel-Birmingham Co.

ROLL LATHE
Lewis Foundry & Machine Co.

SCALES
Toledo Scale Co.
Fairbanks Morse Co.

SHEAR (Hallden)
Wean Engineering Co.

UP CUT SHEAR
Aetna-Standard Engineering Co.

SLAB TRANSFER CAR
William B. Pollock Co.

UNITED
The NEW McDONALD MILL
When you visit the new 43" Hot Strip Mill of the Carnegie-Illinois Steel Corporation, at McDonald, Ohio, during the Spring Conference of the A. I. & S. E., you will see United's latest contribution to the strip mill industry.
DESIGNED and BUILT by
WORLD'S LARGEST BUILDER OF ROLLS

Ruins of old Eureka Blast Furnace built in Wyandotte, Mich., about 1853.

DETROIT -- OUR CONVENTION CITY

In preparation for the society's 32nd convention and iron and steel exposition to be held in Detroit September 22 to 25, Mr. Julius A. Clauss, Chief Engineer, Great Lakes Steel Corporation, has compiled the following very interesting article which should give our members a clear picture of Detroit's early steel history.

▲ IN the village of Ecorse in the Detroit downriver district, is located the Plant of the Great Lakes Steel Corporation, the latest addition to the steel industry. It is located on the Detroit River, and contains about 250 acres.

The erection of this modern steel plant was begun in May of 1929 and the first heat of steel was tapped in August, 1930.

The original installation consisted of:

6—150 ton Open Hearth Furnaces
1—40″ Blooming Mill
1—27″, 24″, and 21″ Bar and Billet Mill
1—30″ Strip Mill
1—14″ Merchant Mill
1—10″ Merchant Mill

In 1935, 2 open Hearth furnaces and additional soaking pits were added.

In 1933, construction was started for a 96″ Hot and Cold Strip Mill and, in February of 1936, ground was broken for 4 additional Open Hearth furnaces. On March 23, 1936, the first strip was rolled in the 96″ Hot Strip mill. The Cold mill installation is nearing completion and the Open Hearth extension will be completed in October.

When the members of our Association come to Detroit next September to attend the 32nd annual meeting and convention, they will be given an opportunity to visit this modern steel plant.

Many of our members may be unaware of the fact that in the neighboring city of Wyandotte, almost within the shadow of the site of this newest giant of the steel industry, in the early eighteen fifties, there was the nucleus of a flourishing steel industry.

We have so long considered Pittsburgh, Penna. as the center of the Iron and Steel Industry, that many of us naturally assume that all the early efforts in making iron and steel were centered in this area.

Michigan, famed for its automobiles and lumber, has always and is still, playing an important role in the development of the Iron and Steel industry.

In 1840, there were fifteen blast furnaces in Michigan, five of which were located in Wayne County.

Detroit, the automobile city, once had two blast furnaces within the present city limits.

In 1856, the Lake Superior Iron Manufacturing Co., of which George B. Russell was president, built a furnace which was put into blast in 1857. This furnace was located in East Jefferson Avenue, now the present site of the United States Rubber Company.

In 1863, the Peninsular Iron Company erected, at the foot of Bellevue Avenue, a blast furnace for the production of charcoal iron.

In 1855, sketches of the City of Detroit, past and present, carried the following interesting account of Wyandotte and its Iron-making activities.

> "This young city, bearing the name of an old Indian Chief, Walk-in-the-Water, after whom also the first steamboat which ever crossed Lake Erie was named, is situated on one of his favorite hunting grounds, on the banks of the Detroit River, ten miles below the city, and promises soon to become a large manufacturing place and a valuable tributary to the business of the city.
>
> A stock company recently purchased the Biddle Farm, containing 2200 acres, from Major Biddle, the front of which embracing two miles on the river and extending half a mile back has been dedicated as the City of Wyandotte. Many lots have already been sold and some thirty tenements erected.
>
> The Eureka Iron Company, who owns extensive iron ore beds on Lake Superior, design to bring down the ore and manufacture it into pigs at this place for which purpose they are erecting a blast furnace. Extensive coal pits are already set up and a large amount of ore is to be brought down from the Lake this fall.
>
> "The Wyandotte Rolling Mill Company are erecting very extensive works. Their main building is now in process of construction, the tin roof being nearly on. The building is 120 ft. square, 29 ft. between joints, and 65 ft. to the top of the cupola. The rolling works are propelled by a large engine, taking its steam supply from five (5) 40-ft. flue boilers, and the trip-hammer is worked by a separate engine.
>
> "The Company have their machinery on the ground complete for the manufacture of bar, roll, band, and other iron. They have a heavy contract for the re-manufacture of railroad iron for the Michigan Central Railroad Company upon which they will commence as soon as their works are in operation."

In 1856, the Iron and Steel industry was intensely interested in the dispute between William Kelly and Henry Bessemer regarding the invention of the pneumatic, now commonly called, the Bessemer process.

We, here in the Detroit area, are particularly interested in this controversy, because in our neighboring City of Wyandotte some of the points in dispute were fought out, and the pages of history are filled with many interesting historical events of the early Steel Industry. Few people in the Detroit Metropolitan Area know that Wyandotte was one of the pioneer steel centers.

About 1857, we learn of the interest taken by Detroit citizens in the Iron and Steel Industry. About this time Captain E. B. Ward of Detroit, Z. S. Durfee, Daniel J. Morrell, and others decided to begin the manufacture of steel by the Bessemer or Kelly pneumatic process in Wyandotte, Michigan.

Wyandotte was selected largely because it was only 15 miles from Detroit, the home of Captain Ward. It was, furthermore, well situated in many other ways.

The country in that day was covered with timber from which charcoal could be made to melt the ore, and, being on the lake, the ore from the Lake Superior region could be obtained by water transportation and much of the product could be marketed by the same means.

J. A. CLAUSS, Chief Engineer
Great Lakes Steel Corp.
Ecorse, Mich.

The construction of this works was begun in 1862. Other iron-masters from Johnstown, Pittsburgh, and some from England became interested in this venture, and the Kelly Pneumatic Process Company was formed.

In 1864, W. F. Durfee, Manager of the Plant, made the first steel by the Kelly process.

The Wyandotte mills not having sufficient power, the ingots were shipped to Chicago where, on May 24, 1865, they were rolled into rails at the Chicago Rolling Mill Company, which company was closely allied with the Wyandotte mill. Several of these rails were laid in the track of one of the railroads running out of Chicago.

The following letter from Mr. O. W. Potter, of Chicago, written to Mr. William F. Durfee in 1865, two days after the rolling of the first American steel rails in that City, is of historical value:

> "Office of the Chicago Rolling Mill, Chicago,
> May 26, 1865.
>
> My Dear Durfee:
>
> The meeting of the iron and steel men adjourned yesterday to meet in Cleveland the fourth Wednesday in August. I regret very much you could not have been here, particularly to see how well your steel behaved, and you must allow me to congratulate you upon its entire success, and I assure you I

was but too proud for your sake that everything we had to do with it proved so very successful. The hammer was altogether too light of course, and it took more time than it otherwise would to draw the ingot down, yet all the pieces worked beautifully, and we have made six good rails from the ingots sent over, and not one bad one in any respect. The piece you sent over forged is now lying in state at the Tremont House, and is really a beautiful rail, and has been presented to the Sanitary Fair by Captain Ward. We rolled three rails on Wednesday and three on Thursday. At the first rolling only your cousin and George Fritz were present; at the rolling yesterday were Senator Howe, of Wisconsin; B. F. Jones, of Pittsburgh; R. H. Lamborn, of Philadelphia; Mr. Phillips, of Cincinnati; Mr. Swift, of Cincinnati; Mr. Kennedy, of Cincinnati; Mr. May, of Milwaukee; and three ladies; Mr. Scofield, of Milwaukee; Mr. Fritz, of Johnstown; and Mr. Thomas, of Indianapolis, with four strangers. Everything went so well I really wanted you to see some of the good of your labors for so long a time and under such trying circumstances. You have done what you set out to do, and done it well, and I am glad to congratulate you and rejoice with you, for I can appreciate some of your difficulties, and wanted you to hear some of the praises bestowed upon your labors as you richly deserve. I know this would make no sort of difference to you, yet we all have vanity enough (especially such cases as this) to feel gratified at any little compliments we know we are entitled to, but I will not tire you with any more, as your cousin (The late Z. A. Durfee) can tell you all and more than I can write, but with kindest regards allow me to remain

Yours Most Obt.,
O. W. POTTER"

In 1880, we find the following interesting account of the industries of Michigan, City of Detroit:

"*Eureka Iron Company*

There is no branch of industry or trade which indicates so plainly the wealth and resources of a manufacturing state as its operations in iron, which may, without exception, be always taken as a true index of its commercial value and standing. Michigan has a large number of iron works, iron companies, and iron mills. But there is no other organization of its kind so extensive in its ramifications as the company of which this sketch gives a short description. The Eureka Iron Company's works are located at Wyandotte, about ten miles from Detroit, and have a full and complete equipment of all the modern and improved appurtenances and appliances for the efficient working of such an enterprise. This company manufactures the celebrated Wyandotte Boiler Plate and Tank Iron, refined and common bar iron, refined and common sheet iron, charcoal pig iron, and every other description of iron manufacturers' supplies required for market. The organization of this company was effected in 1853, at which date it was incorporated with a capital stock of $500,000. During the 27 years of its existence, its trade has constantly increased, and, at the present time, the value of material and finished products alone which are required to be kept in stock amounts to $350,000 while the annual sales aggregate is about $1,500,000. Seven hundred workmen here find constant employment, and, in addition to this manual force, the mechanical power used includes ten steam engines, supplied with power from 26 boilers, which are kept constantly running. The trade extends throughout the North and Northwest and is rapidly penetrating into all manufacturing sections of the Country. Two furnaces and a rolling mill form part of the accessories of this institution, which is the most complete, as well as the largest, concern of its kind in the State, and probably the most extensive industrial enterprise of any kind in Michigan, the yards, workshops, docks and other property covering an area of at least ten acres. The two furnaces have a capacity of 60 tons of charcoal pig iron per day, and the actual daily production includes 25 tons of plate iron, 35 tons of bar iron, 5 tons of sheet iron, and 75 tons of iron rail, or the equivalent. This production of finished material requires the consumption annually of: iron ore, 30,000 tons; soft coal, 20,000 tons; charcoal, 2,100,000 bushels. The men are paid every month, the payroll amounting to $35,000. The office at Wyandotte is located in the Bank Block, while the Detroit office is situated at the corner of Griswold and Larned Streets. The officers of the Eureka Iron Company are Mr. S. P. Burt, President, Milwaukee (Mr. Burt is also Vice-President of the Chicago Rolling Mills Company); Mr. W. S. Armitage, Secretary and Treasurer, Detroit; and Mr. J. S. Van Alstyne, General Agent, Wyandotte. These men are well known and highly esteemed throughout the State and have distinguished themselves as the founders and managers of some of the most successful and solid commercial and financial enterprises in Michigan."

It is interesting to note that the Bank Block referred to is the building now occupied by the Wyandotte Savings Bank, corner of Biddle Avenue and Elm Street.

In Michigan, a bushel of charcoal weighs twenty pounds, so then 2,100,000 bushels of charcoal totalled 21,000 tons.

In 1876, The Eureka Iron Company sent to the Centennial Exposition in Philadelphia the largest plate of iron ever made up to that time.

The Wyandotte Rolling Mill consisted of a small merchant mill, having a 10″ roll train; a plate mill, which in its day was considered the best in the Country;

a rail mill; and a sheet mill. The original blast furnace, built in 1855, had a capacity of 10 tons a day and was gradually enlarged until it had a production of 60 tons a day. The second blast furnace was built in 1863. It was in the east houses of these blast furnaces that the first experiments in making Bessemer steel were made. The Bessemer Converter, built in 1864, was of 2½ tons capacity and was operated until 1869.

The panic of 1873 affected the Wyandotte Rolling Mill seriously and it was forced into bankruptcy in 1878. This Mill was taken over by The Eureka Iron Company, which company successfully operated it for some years.

The age of iron was passing and the steel age had come. Increasing competition from the Pittsburgh district; the lack of a suitable fuel for steel-making; the rapid advance of steel mill machinery; making obsolete the rolling mill company equipment; a disastrous boiler explosion in June 1888, in which a number of men were killed; some labor trouble; and the burning down of the plate mill finally caused this mill in 1890 to fade out of the picture. And thus the Detroit area, which had been the birthplace of cheap steel and had ranked in the fore-front as an iron and steel center, lost its chance to be the steel center of the Country, and the honor went to Pittsburgh, Pennsylvania.

In 1903, the Detroit News, under date of September 28th carried the following news item:

> "Detroit is to become the center of the lower lake traffic, if present plans do not miscarry, and other capitalists realize the natural advantages this City has in a loading and unloading port, as have the promoters of the Zug Island plant on the River Rouge. For years cargoes of ore have passed Detroit to be unloaded at some Lake Erie port, but until this morning at 10 o'clock, when the huge clamshells were put into operation at the plant of the Detroit Iron and Steel Company, not one was unloaded here. The 'City of Genoa' carried the first load of iron ore to Detroit yesterday (September 27, 1903) morning and is being unloaded by the most approved machinery at the new furnaces."

This item has reference to what was then the new blast furnace plant on Zug Island and what is now Furnace "A" of the Hanna furnaces of the Great Lakes Steel Corporation.

Six years later The M. A. Hanna Company, recognizing the significance of the rapid growth of the City of Detroit as effecting local iron consumption, early in the year 1909 began preparations to increase the capacity of the Detroit Iron and Steel Company's plant on Zug Island by the addition of a second blast furnace, which was blown in July 21, 1910. Extensive additions were also made to the ore docks and storage yards, and additional blowing engines, steam boilers, water pumps, and yard tracks were also installed. This furnace is now called Furnace "B" of the Hanna Furnace Plant of the Great Lakes Steel Corporation.

With the growth of the Automotive Industry, the Detroit area became the largest steel consuming center in the country.

The early and brilliant start of the Iron and Steel Industry in this area failed because of the lack of fuel and a market. Today, these handicaps no longer exist; the question of fuel is now solved by the efficient use of fuel oil and no better market exists for steel than Detroit; for certainly, Detroit with its one and a half millions of people, its splendid water facilities which carry a tonnage of seventy-five millions tons of freight, valued at a billion and a half dollars, its twenty-five thousand manufacturing plants, its automobile production of three and a half million cars, valued at two and three quarter billion dollars is a logical place for a steel center.

In 1922 Detroit again took its place in the limelight of the industry as a possible steel producing center when the Michigan Steel Corporation built a Sheet Mill in Ecorse.

The Detroit Steel Corporation was started in 1924 and 1925 saw the beginning of the Ford Steel Plant. The Great Lakes Steel Corporation and the Bopp Steel Corporation started in 1929. Then, in 1933, came the Rotary Electric Steel Company.

Our September meeting and Exposition is attracting considerable attention and the indications are that it will be the largest and most successful annual meeting in the history of our Association.

View of Detroit showing skyline from the Detroit River

PROBLEMS OF MOTOR APPLICATION

FOR CONTINUOUS MILL AUXILIARIES

By F. E. HARRELL, Assistant Chief Engineer
Reliance Electric & Engineering Co.
CLEVELAND, OHIO

Paper presented before the Chicago and Birmingham Sections of Association of Iron & Steel Electrical Engineers

▲ THE unusual activity during the past several years in the construction and operation of continuous hot strip mills has presented such a variety of problems that probably no one person nor company is prepared to even outline them all, much less offer their complete solution. Consequently, it shall be the object of this paper simply to consider a couple of typical auxiliary drive problems. To do so will serve the purpose of furnishing type cases illustrating the principles to be set forth in the latter portion of this paper as applicable to other cases.

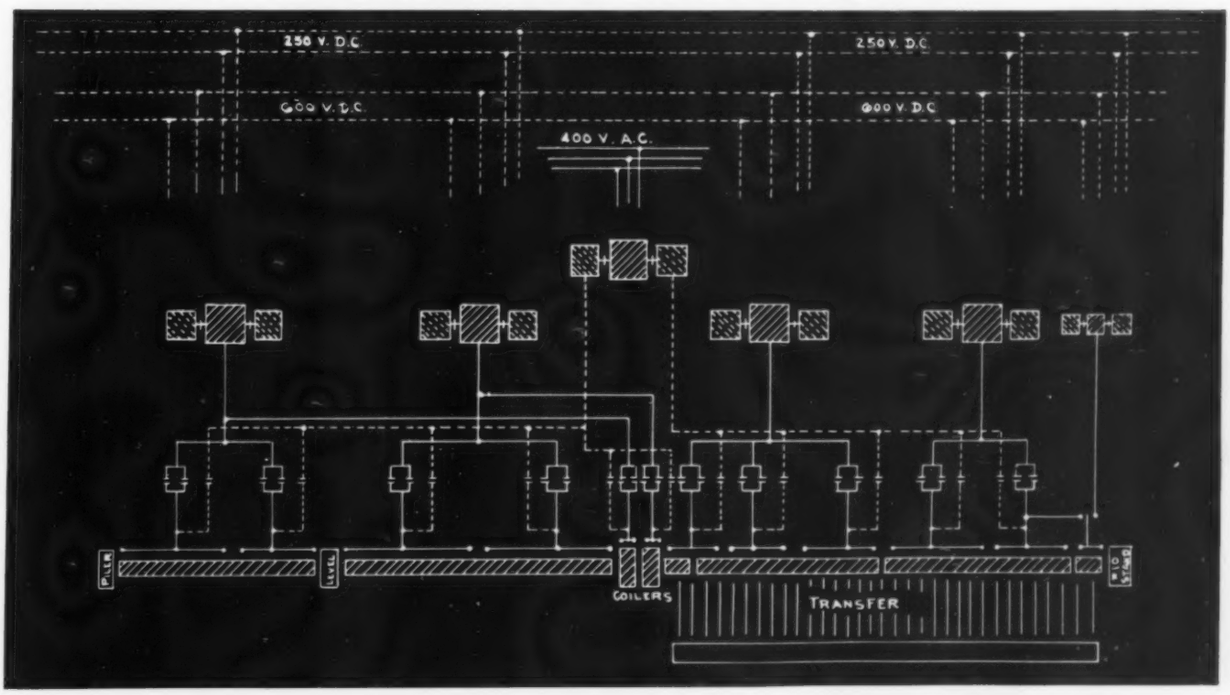
By way of introduction also, it is in order to here record the fact that whereas by virtue of his position, the electrical manufacturer is likely to appear to be the Houdini or the Steinmetz in any individual case, this is not so. The facts of the matter are that the electrical men in the mills, and with the operating companies and those of the mill builders deserve whatever credit there is for the present advanced position held by the electrical industry in this new field. The electrical manufacturer and designer is simply an instrument in the hands of those aforementioned.

PROBLEM CASE ONE—RUNOUT TABLES

Much has been heard recently in connection with individual drive for runout table rolls. Papers on this subject alone have been recently presented before this Association by authors representing three manufacturers. It shall not be the purpose of this paper to further discuss the possible controversial angles of this application, but rather to brief the essential considerations in connection with laying out a runout table drive.

It has become quite generally accepted to consider the tables at the finishing end of a continuous mill for

Fig. 1—Schematic layout of finishing end of wide hot strip mill



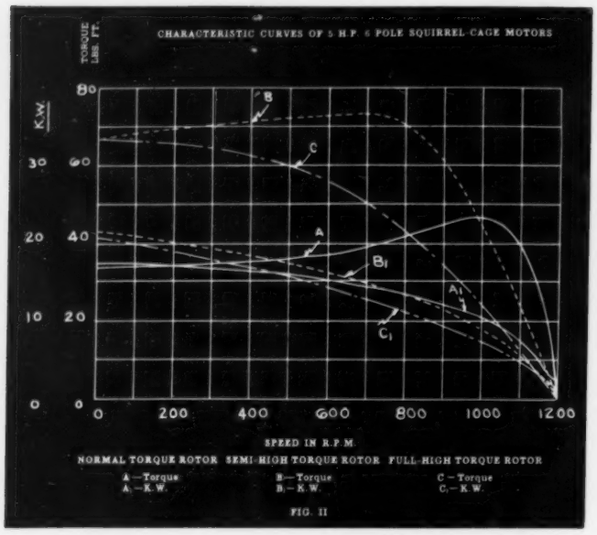


FIG. II

individual drive. Incident to the economics of maintenance and flexibility for operations, the squirrel cage motor powered from a separate adjustable speed motor alternator set has evidently become a fixture for this purpose.

The question has been asked if direct current is required for the motor alternator set back of the A-c. motors, why not use individual drive, consisting of D-c. motors? The answer is four-fold:—first, the cost of the D-c. motors plus control and wiring is sure to exceed that of the A-c. motor plus control, plus motor alternator set and wiring by amounts varying from ten to one hundred percent; second, the maintenance incident to D-c. motors as opposed to squirrel cage together with their frequently inaccessible locations, favors the squirrel cage motor; third, the vibration frequently encountered on the best mountings available for the individual motors, is too severe to be conducive to satisfactory commutation; fourth, 600 volts D-c. is supplied for the motors on the motor alternator sets placing two 300 volt motor armatures in series across 600 volts, whereas it would not be practicable either from the standpoint of wiring on motors to use 600 volts D-c. directly for D-c. table motors.

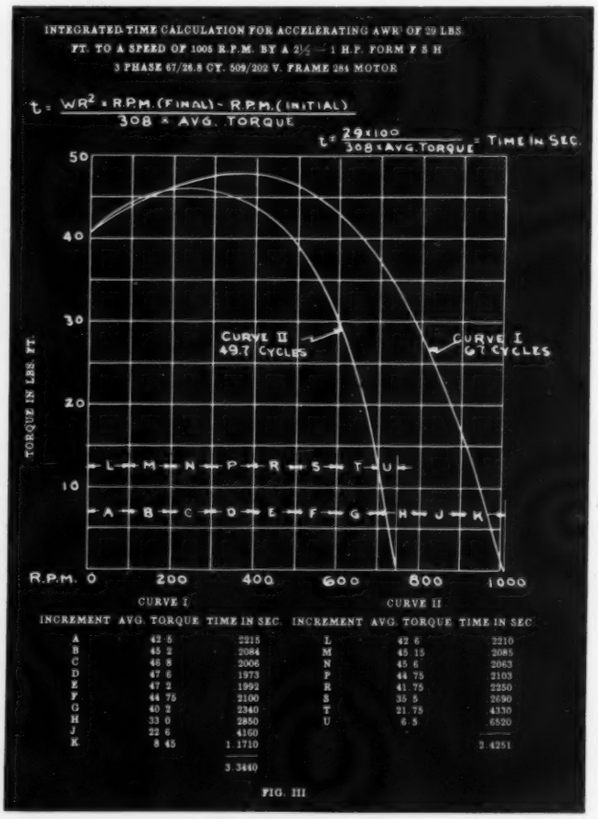
A typical installation is outlined on the schematic diagram of the finishing end of a wide hot strip mill illustrated in figure I.

600 volts D-c. is supplied for the armature circuit of the motor alternator sets. 250 volts D-c. is supplied for excitation purposes of both D-c. motors and control. Some A-c. potential of standard voltage and frequency is supplied for the synchronous or induction motor driving the D-c. braking generator.

Consider first the D-c. motor driving the alternator set. These motors are regularly as individual units, something smaller than 400 hp. at 400 r.p.m., usually in the so-called general purpose motor range. It has been found that incident to the type of overload conditions under which these motors must function properly, and incident to some of the transient condition encountered on the 600 volt D-c. system from which the main drive motors for the mill stands are supplied, it is most practicable to restrict the armature voltage to not over 300 volts. For this reason most such drives are laid out with twin motor drive for the alternator, each motor with a 300 volt armature, the two in series across the mill supply, but separately excited from a 250 volt supply, usually provided expressly for excitation purposes. These motors are field weakening up to about 3:1 range, and are regularly called upon to take 200% peaks of five to ten seconds duration and recurring sometimes twice a minute. Dependent upon the control scheme employed, and the duty cycle, the matter of WR^2 of this motor may be a consideration.

Next let us consider the alternator portion of these sets. Usually of the rotating field type, the alternator is made the fewest number of poles permissible consistent with a safe maximum speed of both alternator and driving motor. Except in the case of very low frequencies and relatively small capacities (200 KVA or less), two pole alternators are never used for this service. Four pole machines are frequently used in capacities up to about 350 KVA, while six pole alternators are popular in all sizes.

In recognition of the fact that the squirrel cage motors selected of necessity operate at only partial load, and consequently at a poor power factor, also that the voltage regulation of low, lagging power factor alternators is better partially because they are larger—low power factor alternators are to be recommended for this purpose. Fifty percent power factor machines are always applicable, and while individual cases may justify the use of higher power factor machines, still the voltage regulation of the alternator or its ability to hold up voltage under extreme overload is always of sufficient moment to justify the use of a fifty percent


INTEGRATED TIME CALCULATION FOR ACCELERATING WR^2 OF 29 LBS. FT. TO A SPEED OF 1005 R.P.M. BY A 2½—1 H.P. FORM F S H 3 PHASE 67/26.8 CY. 509/202 V. FRAME 284 MOTOR
$t = \frac{WR^2 \times R.P.M.(FINAL) - R.P.M.(INITIAL)}{308 \times AVG.\ TORQUE}$
$t = \frac{29 \times 100}{308 \times AVG.\ TORQUE}$ = TIME IN SEC.
TORQUE IN LBS. FT.
50
40
30
20
10
CURVE II 49.7 CYCLES
CURVE I 67 CYCLES
L M N P R S T U
A B C D E F G H J K
R.P.M. 0 200 400 600 800 1000
CURVE I
CURVE II

INCREMENT	AVG. TORQUE	TIME IN SEC.	INCREMENT	AVG. TORQUE	TIME IN SEC.
A	42.5	2215	L	42.6	2210
B	45.2	2084	M	45.15	2085
C	46.8	2006	N	45.6	2063
D	47.6	1973	P	44.75	2103
E	47.2	1992	R	41.75	2250
F	44.75	2100	S	35.5	2650
G	40.2	2340	T	21.75	4330
H	33.0	2850	U	6.5	6520
J	22.6	4160			
K	8.45	1.1710			3.4251
		3.3440			

FIG. III

power factor alternator instead of the seventy or eighty per cent power factor machine.

Inasmuch as the alternator size is practically always determined by the starting requirements of its connected load, every precaution is taken that will favor voltage regulation both in the design of the machine and its operation. Alternators for this purpose are now designed for an over-excitation during the period of starting its connected load by at least 150% field forcing. By this means an alternator is enabled to maintain full voltage in the presence of 150% load. Of course, we must recognize that the field forcing is applied conincidental with the throwing on of the A-c. load, so that the inductance of the alternator field causes a slight time lag in building up to the higher value, so the above statement is only indicative and is subject to revision incident to the conditions of any particular installation.

In this connection it may be in order to point out that standard voltage regulation for alternators of this class is 40%. That is, an alternator carrying full load at rated voltage and power factor will have a no load voltage for the same speed and field current of 140% of the full load value. Incident to the extra precautions taken in design, this value is not likely to be reached, but may be insofar as specifications are concerned.

An additional consideration not regularly of concern with alternators is the fact that frequently for runout table service, a speed range sufficiently wide is employed as to cause concern over the ability of the alternator to dissipate the necessary losses at the minimum speed.

The runout table motors may now be considered. Insofar as the details of torque, number of poles and frequency are concerned, reference may be made to a joint paper participated in by the author, and published in the August, 1935 Iron & Steel Engineer. Let us here consider some of the more general details.

The most preferable type of individual drive is the direct connected squirrel cage motor coupled directly to the roll. There are occasional cases where space limitations such as those presented by a double transfer necessitate the introduction of gearing to prevent the motor from extending above the top of the roll at either end. Gear-motors are commonly offered for such cases.

While there is much to be said for gearmotors, it is equally true that gearmotors contain gears and additional bearings which must be maintained. Except for the occasional case of space limitation referred to above, the use of gearmotors at a normal high frequency may be dispensed with by going to a direct connected motor with a larger number of poles, or by going to a lower frequency or both.

Possibly an extreme case illustrating this point is an installation now being made in the Chicago district where several short tables will operate with direct connected motors wound for poles as high as 28, and operating at frequencies as low as 4.5 cycles.

Before leaving the subject of runout tables, it will be in order to make a brief reference to methods of control. Three general methods of starting are now employed although still others have been used. First, for continuous running tables not subject to frequent starting or stopping, starting may be accomplished by

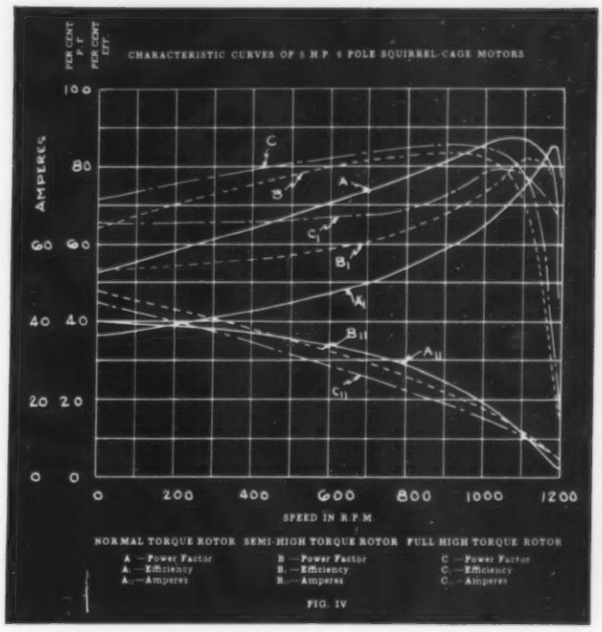


FIG. IV

throwing the entire table onto its alternator at one time at its regular operating speed. This severe punishment of the physical equipment occurring once a day, or once a shift is practicable. Second, where starting and stopping occurs according to a regular schedule of operations, and where time permits, the motor alternator set may be decelerated to low speed for starting or plugging, then the table accelerated to its operating speed through the driving motors on the motor alternator set. Third, where a schedule of operations incident to transfer and shearing may require extremely rapid acceleration of a portion of a table to a high speed in a very short time, say fifteen hundred f.p.m. in three seconds, then the economical way is to employ group starting whereby a portion of the motors at a time are thrown onto the alternator already running at the proper operating speed.

PROBLEM CASE II—UPCUT SHEARS

Incident to some of the subsequent operations to be performed on the strip in coil form, an interesting problem was presented by the powering of an upcut shear intended for use about twice in three minutes. Such a shear is used for example in the continuous pickling line for strip coils.

The problem here is three fold insofar as the drive is concerned. The power plant must accelerate the shear, make the cut and stop, all very quickly and accurately. The inertia of the shear is a very small amount when reduced to the motor shaft, by dividing the actual physical value in pounds feet squared by the square of the reduction ratio.

From the standpoint of acceleration alone, a small motor with a very low inertia rotor and wound for a low speed would be preferred. However, for the work of shearing very high torques must be available—on the order of 1500-2500 lbs. feet as a maximum. This latter requirement is, of course, directly opposed to the former, but must be satisfied. Since the motor

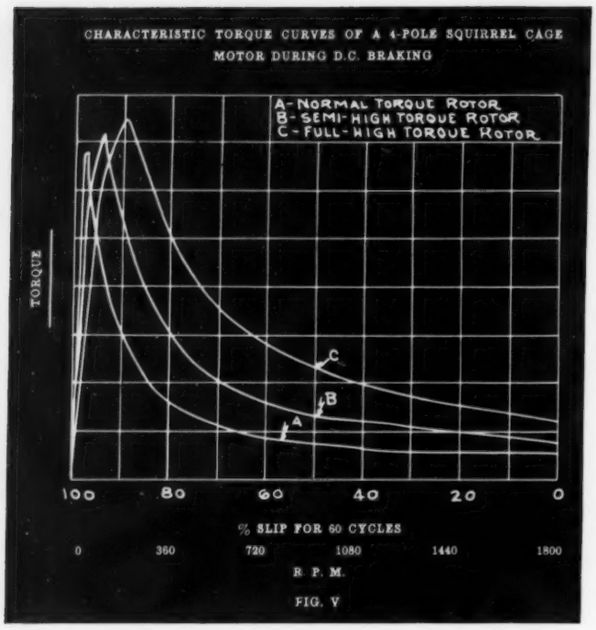


FIG. V

must be stopped accurately, and held in position, an external brake is provided for this purpose, serving also, of course, to reduce the heating of the motor since the loss to accelerate the additional inertia represented in the brake wheel is many times offset by the motor being relieved entirely of the loss incident to stopping.

This motor then becomes one having a very high maximum torque as the outstanding requirement, with consequently the ability to accelerate rapidly,—less than one-fifth of a second, and with the ability to dissipate the total losses incident to this duty cycle. Such a motor is one having about one-fourth the continuous torque rating represented by this demand, since for this intermittent service the torque may be secured by boosting the flux density in the motor to an abnormal value—such as would be secured by putting double voltage on a motor winding. This is practicable only because it occurs for a few seconds at a time, and with sufficient interval between applications to avoid overheating.

A brief statement here concerning the use of direct current motors for continuous mill auxiliaries may be in order. With all of the developments in electrical apparatus, and equipment over succeeding years, no satisfactory or equivalent substitute has yet been discovered to replace the field weakening, adjustable speed direct current motor where an individual machine is concerned. Such auxiliary drives as leveller, flying shears, pinch rolls, tinning and cleaning machines, cold reduction and skin pass mills with tension reels, slitters, trimmers, etc., in the new continuous strip mills bear mute testimony to the above assertion.

As the electrical manufacturer has been called upon to apply individual motors to machines not previously so driven, he has rather insistently kept asking questions concerning the application in the interest of applying the correct size and type of motor. To this end the trade has very generally become "inertia minded" coming to think readily in terms of WR^2, and willingly giving this very necessary information to the motor manufacturer to permit him to analyze the problem and make an intelligent recommendation.

This willingness and ability is so generally accepted and recognized, that the author is encouraged to spend a little time talking about the general characteristics of the three most prominent types of squirrel cage motors, viz: normal torque, semi high torque and high torque.

It would doubtless prove extremely helpful in any consideration of a motor problem if one could associate a speed torque curve with a given type of motor. Fig. II shows speed torque curves for these three types as well as speed KW input curves. A study of these curves alone showing input and output from the motor at all speeds from standstill to synchronous would answer a great many questions arising as to what may be expected of such a motor.

It may be of interest to note that the maximum torque point moves from a point near synchronous speed toward the locked or stalled position as the rotor resistance is increased until with a rotor resistance four to five times normal the maximum torque occurs at standstill, as evidenced by the high torque motor.

Of course, along with increased rotor resistance comes increased slip which means running at a lower speed for the same horsepower output, and at a lower efficiency.

By comparing the KW input at the full load point with that at some low speed point, it is easy to understand why a 1200 r.p.m. motor running at a low speed (from full rated frequency) will get exceedingly hot although carrying a very low horsepower load since

$$HP. = \frac{\text{Torque x R.P.M.}}{5252}$$

It becomes readily understandable why high slip motors are usually given an intermittent rating.

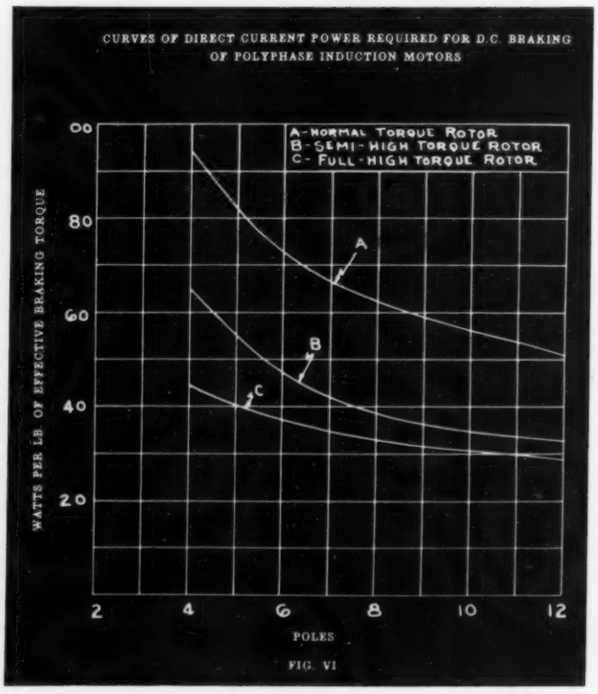


FIG. VI

Fig. 7—Straight fully enclosed motor.

Fig. 8—Fully enclosed fan cooled motor.

Fig. 9—This shows splash proof motor.

A proper appreciation of the fundamentals of mechanics is, of course, a very helpful factor in analyzing these curves, and adapting their predictions to a given problem.

Accepting the well known formula for the torque required for acceleration,

$$T = \frac{WR^2 \times R.P.M.}{308 \times t}$$

it may be of interest to observe the further use of the speed torque curve to predict a time of acceleration. Referring to Fig. III, it will be seen that by dividing the curve into small parts with regard to speed, and placing the average value of torque and the speed change into the torque formula, the time of acceleration through this speed increment is secured. By going through this procedure over the entire range of the curve, and adding the times, the total time for acceleration may be predicted.

With experience in this connection, and with data as to the shapes of curves of different types and numbers of poles, it is readily possible to closely approximate the time of acceleration of a given problem case by applying a suitable factor representing the ratio between starting torque and average effective accelerating torque. For any very approximate purpose, it is usually sufficient to assume that the required accelerating torque represents ⅔ of the starting torque.

It may be surprising to note that as shown by this integration, the motor is accelerated to 80% speed in 50% of the time which is quite a normal relation.

Of further use in various problems, especially those of the runout table and alternator set selection are the curves in Fig. IV, showing speed-current, speed power factor, and speed-efficiency relations for these three types of motors.

Another well known phenomenon not often used with squirrel cage motors is that of D-c. braking. Curves of D-c. braking, the three types of motors are represented in Fig. V. Such curves may be produced by driving a squirrel cage motor by a dynamometer while applying a direct current potential to the stator terminals.

An integration of this curve exactly as in Fig. III for acceleration would accurately predict the stopping time. However, incident to the preparation of a paper on the subject of "D-c. Braking of Induction Motors" recently presented before the A.I.E.E., and appearing in Electrical Engineering for May, 1935, the author with his collaborator Mr. Hough has produced a chart Fig. VI by the use of which the mechanics of D-c.

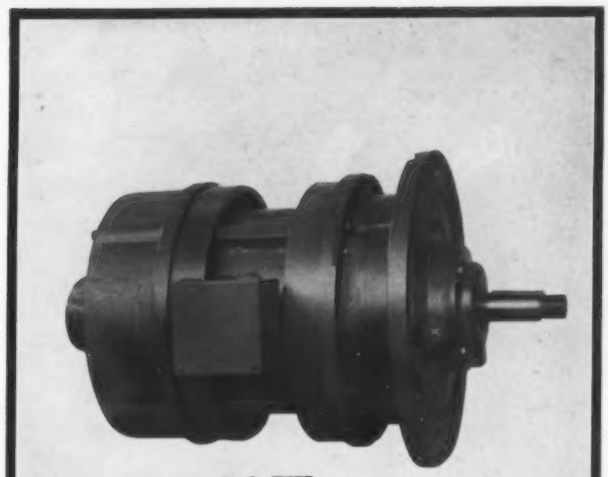


FIG. VII

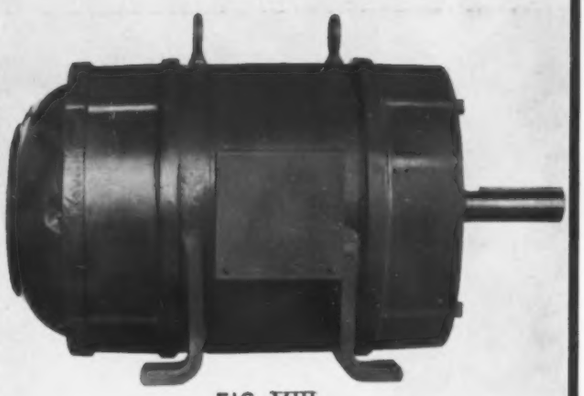


FIG. VIII

FIG. IX

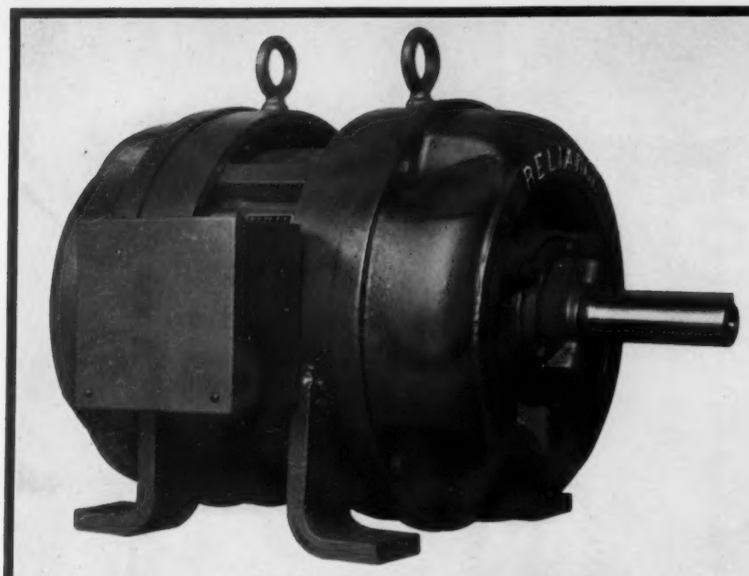


FIG. X

Fig. 10—This is the well known open type of motor.

FIG. XI

Fig. 11—Water cooled motor for very severe applications.

braking is readily calculated with reasonable accuracy.

Determining the average braking torque necessary through the torque formula above, and going to Fig. VI for the watts per pound necessary to produce this torque, it is then a straight forward calculation to volts and amperes for connection to two of the three terminals of a polyphase motor to secure this desired braking effect.

For example:—

Load Inertia (including motor rotor)	20 lbs. ft. sq.
Time to stop	2 Seconds
Motor Speed	1200 r.p.m.
Motor terminal resistance	25 ohms.

Normal Torque motor

$$T = \frac{20 \times 1200}{308 \times 2} = 38.8 \text{ lbs. ft.}$$

From Fig. VI use 72 watts per lb.

$72 \times 38.8 = 2793.6$ watts D-c. input to motor.

$$I = \sqrt{\frac{W}{Rt}}$$

$$\sqrt{\frac{2793.6}{2.5}} = 33.4 \text{ amperes D-c. current}$$

$33.4 \times 2.5 = 83.2$ volts

Power required is 33.4 amperes at 83.2 volts totaling 2.79 KW to stop the motor with its load in two seconds.

In conclusion, it may be of interest to note in the inverse order of their effectiveness the various types of enclosure of squirrel cage motors readily applicable to continuous mill auxiliaries, depending on the losses disclosed from the analysis of the prescribed duty cycles, and a study of the ambient temperature and other surrounding physical conditions.

To compare various types of motors of the same given dimensions the least effective in dissipating ability, but probably the most effective in restraining the entrance of foreign materials is the straight fully enclosed motor shown in Fig. VII.

Progressively upward in dissipating ability is the fully enclosed fan-cooled motor shown in Fig. VIII. This type of motor is very definitely recognized as having limitations with regard to overload capacity as compared to open types.

Next in effectiveness is the splash-proof motor shown in Fig. IX. This motor offers real protection against heavier than air metal particles.

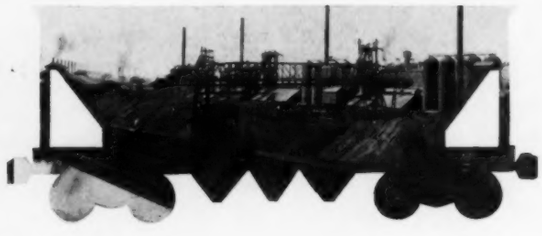
The open motor of Fig. X is well known, and its normal capacities and overload capacities are pretty well understood.

For more severe jobs, the open motor may be supplemented by a separate air supply, and made a force ventilated motor.

For still more severe applications of frequent starting, or other serious heating problem, the water-cooled motor of Fig. XI may be necessary.

While illustration cannot be shown, there are such severe jobs being attempted by squirrel cage motors as to cause serious consideration to be given to a motor to be supplied with a water-cooled stator with forced ventilation through the motor to cool the rotor.

The purpose of this paper will have been served if any of the applications mentioned, or characteristics cited prove of benefit to some other application problem.



▲ ▲ ▲ ITEMS OF INTEREST ▲ ▲ ▲

Fred Clements, an active member of the Association, and General Manager of the Park Gate Iron and Steel Company, Ltd., of Rotherham, England, has been awarded the Bessemer gold medal which is recognized as the highest honor within the gift of the council of the British Iron and Steel Institute. The medal, which was endowed in 1873 by the late Sir Henry Bessemer, the famous Sheffield steel manufacturer and inventor of the Bessemer process, is awarded each year on an international basis in recognition of services rendered to the iron and steel industry. Numbered among the past recipients are Henry Marion Howe in 1895, Andrew Carnegie in 1904, and Mr. Charles Schwab in 1928.

Mr. Clements, in addition to the active part he has played in the development of the Park Gate Works to their present high standing among producing plants, has gained recognition as an expert in the iron and steel industry, and his opinion is sought as a consultant in many directions. His influence on technical progress however has been international by his contributions of the results of industrial research to the Proceedings of The Iron & Steel Institute. These were deemed in this country, and even to a greater extent abroad, to introduce a new line of attack on industrial problems which has been followed since with considerable success.

In 1929 Messrs. Benn Ltd. published, in three volumes, his work entitled Blast Furnace Practice. This study, which reviewed the process of pig iron manufacture in all the producing countries of the world, has had a wide circulation both at home and abroad. It is regarded as one of the most important additions to technical literature in this generation.

Mr. Clements, who contributed articles to the last edition of the Encyclopedia Britannica, is a Member of Council of the Iron & Steel Institute. He is also a Member of the Industrial Research Council of the British Iron & Steel Federation, being Chairman of the Blast Furnace Committee of that organization.

H. E. Lewis, chairman of the executive committee of the Jeffrey Manufacturing Company, Columbus, Ohio, since November, 1930, and prior to that executive vice president of the Bethlehem Steel Company, will shortly become a director and chairman of the board of the Jones & Laughlin Steel Corporation.

He will succeed George M. Laughlin, Jr., who has been chairman since 1928, and who is the son of Major George M. Laughlin and the grandson of James Laughlin, one of the two original partners in Jones & Laughlin's. Mr. Laughlin's resignation will be effective upon completion of the present financing of the company.

Mr. Lewis is widely-known in the steel industry and versed in finance as well as operations. Born in Wales, he came to this country in early childhood, worked for the Carnegie Steel Company in Pittsburgh, then went with Bethlehem, becoming vice president. He resigned this post in 1930 to go with the Jeffrey Company. He also is a director of the Kelsey-Hayes Wheel Corporation, Detroit.

▲

J. J. Bangert, Pittsburgh district manager of the Crouse-Hinds Company, is now located on the ninth floor of the Empire Building where he may be reached in room 918. Mr. Bangert moved into his new headquarters April 1.

▲

Philip A. Singleton and **Jack K. Williams** have been added to the sales department of the Reliance Electric and Engineering Company. Mr. Singleton will be located in Philadelphia and Mr. Williams in Chicago.

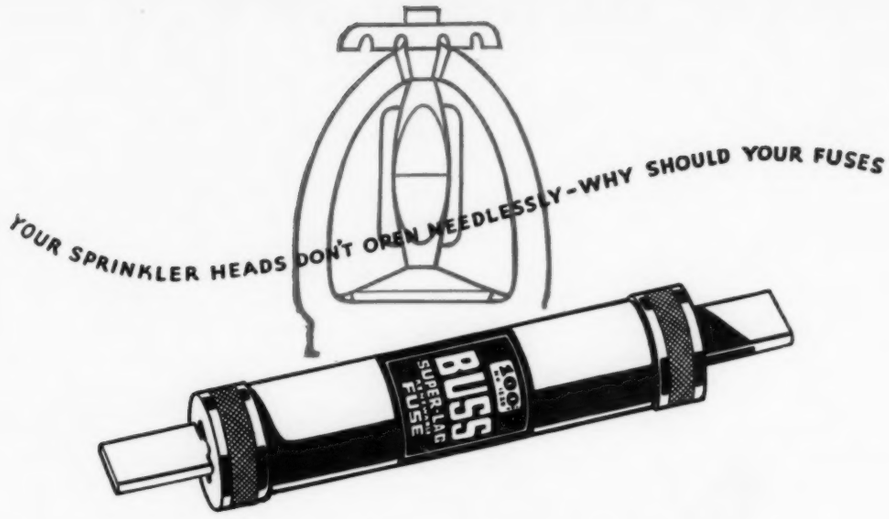
▲

F. R. Magill, well known steel mill representative for various manufactures of equipment in the Pittsburgh district, is now also associated with the Trabon Engineering Company, Cleveland, Ohio. Mr. Magill will handle this account for the Trabon Company in the Pittsburgh area.

(Please turn to page 62)

FRED CLEMENTS
"awarded the Bessemer Gold Medal"

H. E. LEWIS
"to be J. & L. director and chairman of the board"



FUSES MADE TO PROTECT—NOT TO BLOW

Saved us over $5,000!

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SO SAYS . . . Mr. Robt. E. Bell, Chief Engineer, Martin Dyeing and Finishing Co., Bridgeton, N. J. He continues "We had been having great trouble making the 600 ampere fuses on our main switchboard hold. They blew so frequently that we even resorted to the practice of doubling up on the links to give us a fuse of about 1200 amperes. But we still had a lot of blows that shut down the plant and threw a large body of men out of work.

Finally one of our men suggested trying out some 600 ampere BUSS Super-Lag Fuses. We did — that was three years ago — they haven't failed yet. We attribute this remarkable result to the design of the BUSS One-Piece Link and to the BUSS Super-Lag feature."

GET THE FACTS—*about fuses that . . . .*

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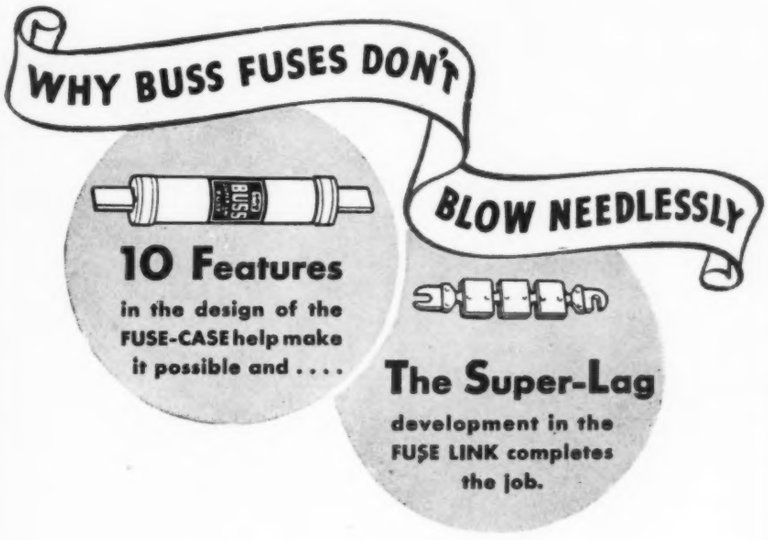
Like Mr. Bell thousands of executives each year are finding a way to safeguard their equipment against electrical hazards and to protect their plant operation against useless interruptions by using fuses designed to protect—not to blow. These men have found it a money saving investment to investigate . . .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in the design of the FUSE-CASE help make it possible and . . . .
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Assuming your interest in getting the facts on the **relation of plant operating costs to fuse design,** we have gone to great lengths in this book to set them up for your consideration.

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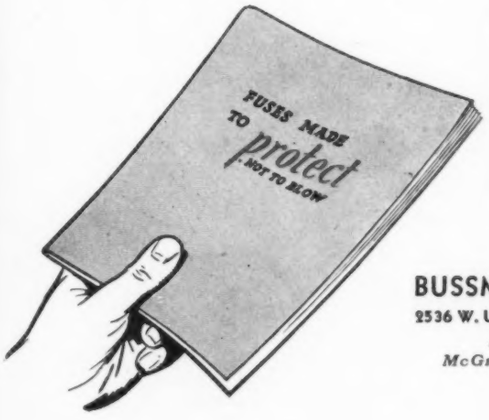

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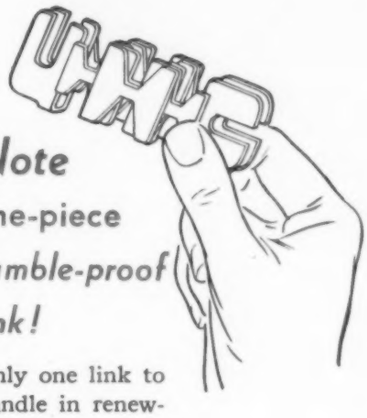

Note one-piece *fumble-proof link!*

Only one link to handle in renewing—even on the larger sizes.

From 200 ampere up, links have copper terminals and no washers are used with them.

Good contact between the link and the fuse terminals is obviously easy to get when the fuse is renewed.

Maintenance men who have had grief with the old "jig-saw" method of using a number of links and a lot of loose washers to make the larger amperages will welcome the BUSS one-piece link.

They know that heat from poor contact must be prevented from developing between the link and the fuse terminals—or else needless blows and shut down circuits result.

They recognize in the BUSS link a real improvement that helps make possible "Fuses made to protect—not to blow."

BUSS super-lag FUSES

HARRY A. WINNE
"new manager of mining and steel mill section at General Electric"

Harry A. Winne and **John C. Miller** have been appointed managers of sales for two sections of General Electric Company's industrial department as recently announced by J. E. N. Hume, manager of the department. Mr. Winne, formerly in charge of the steel mill section of the industrial engineering department, has been made manager of the mining and steel mill section, succeeding K. H. Runkle who was recently made an assistant manager of the industrial department. Mr. Miller, who has been in charge of the department's aeronautical section for some time, has been appointed manager of sales for that section.

Mr. Winne, a native of Cherry Valley, N. Y., attended Syracuse University, graduating in 1910 with a degree in electrical engineering. The same year he entered the employ of General Electric as a student engineer in the testing department. In 1911 he became head of the large motor, generator, and synchronous converter test, and about a year later was made assistant general night foreman of the testing department. He was promoted to the power and mining engineering department, now the industrial engineering department, in 1916 and there worked on problems concerned with industrial heating, arc welding, and electric furnace equipment. In 1922, he was transferred to the industrial engineering department's steel mill section, and became head of that section on May 1, 1930.

Mr. Miller, a native of Schenectady, attended Princeton University and first entered the employ of the General Electric Company during his summer vacation from that institution in 1926. In 1927, he worked for a time in the West Philadelphia works of the company, and then during the same year joined the accounting department in Schenectady and entered the company's business training course. On April 1, 1930 he was transferred to the aeronautical section of the industrial department, and was placed in charge of that section in January, 1932.

JOHN C. MILLER
"manager of sales for aeronautical department of General Electric"

∴ OBITUARIES ∴

George Gordon Crawford, for many years president of the Tennessee Coal, Iron & Railroad Co., and from 1930 to 1934 president of the Jones & Laughlin Steel Corpn., died in Birmingham on March 20. He was born Aug. 24, 1869, in Madison, Ga., and was graduated from Georgia School of Technology in 1890. After two years of study at Karl-Eberhard University at Tubingen, Germany, he returned to this country and became assistant superintendent of the Edgar Thompson blast furnaces of the Carnegie Steel Co. From 1897 to 1899 he was superintendent of the blast furnace and steel works of the National Tube Co., at McKeesport and then superintendent of the Edgar Thomson furnaces for the next two years. He was manager of the tube works and plants of the National Tube Co., when he was transferred to Birmingham in 1907 as president of the Tennessee Coal, Iron & Railroad Co. He resigned to become president of the Jones & Laughlin Steel Corpn. in 1930. After his retirement in May, 1934, he devoted his time to personal affairs.

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Phillip King, service engineer, Keystone Lubricating Company, died in St. Louis, Mo. April 4. Mr. King, an associate member of the Association, was very well known in the steel industry, being located in the Pittsburgh area for many years. He was buried in St. Louis his early home city.

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Raymond Dill, treasurer of the Allis-Chalmers Mfg. Co., Milwaukee, died on March 17, aged 55 years. He was born in Ohio and after being graduated from the school of electrical engineering at Ohio State University in 1901, was connected with the Westinghouse Electric & Mfg. Co., Pittsburgh, until 1905, when he joined the engineering staff of the Bullock works of Allis-Chalmers at Cincinnati, later being transferred to the treasurer's department there. In 1908 he was appointed assistant treasurer at the main office in Milwaukee, and in 1923 he was promoted to treasurer of the corporation.

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Richard G. Blotter, assistant treasurer, National Tube Co., Pittsburgh, died suddenly on March 16, aged 44 years. He had held his position with the company since 1931.